National Aeronautics and Space Administration
Contract No. NASw-6

JPLAI/Abstracts/Volume I

ASTRONAUTICS INFORMATION

ABSTRACTS WITH INDEX
Volume I, Parts A, B, C, D
(Abstracts 1,001–1,726)

Copy No. HC 54

JET PROPULSION LABORATORY
California Institute of Technology
Pasadena, California
January 15, 1960

PREFACE

During 1959 the Jet Propulsion Laboratory produced a series of documents entitled Astronautics Information Abstracts. Volume I, Parts A, B, and C abstracted and indexed unclassified reports (pertaining to certain aspects of astronautics) received at the JPL Library up to September 1959. Volume I, Part D was designed to contain material received during the period September–December 1959.

Due to the excessive demand for the early volumes and also for the convenience of the user, Parts A, B, and C, are reprinted here, together with Part D. This present document therefore is Volume I *in toto*, cumulating all abstracts and an index of all astronautics material received at JPL up to January 1960. Classified abstracts are to be published in Part E (SECRET) of Volume I.

In general, coverage of Astronautics Information Abstracts is restricted to the subject of spaceflight and to applicable data and techniques. Areas currently being reported by other information agencies are usually excluded. However, data and techniques arising from other technologies are reported if the relationship to astronautics is clear. For example, coverage is given to propulsion when related to specific space travel missions and to meteorology when related to the envelope beyond the stratosphere. Aeronautics, communications, guidance, instrumentation, materials, vehicle engineering, etc., are treated similarly, the intent being to give full coverage to astronautics but to exclude peripheral material.

The JPL library does not presently have copies of the abstracted material available for outside loan. It is therefore suggested that users requiring copies request them from the cited originator. For convenience of the user, Armed Services Technical Information Agency (ASTIA) AD numbers have been included in the citation when known.

In order that users may enjoy the most complete coverage possible, recipients of these publications are urged to contribute material dealing with astronautics for inclusion in the JPL abstracting program. JPL is listed in Part A of the Guided Missile Technical Information Distribution List (MML) and has been authorized by the Secretary of Defense to receive copies of all pertinent documents classified through Secret.

ASTRONAUTICS INFORMATION ABSTRACTS, PART A

January 1–December 31, 1958

1,001 CATALOGUE OF DISTURBANCES IN IONOSPHERE, GEOMAGNETIC FIELD, FIELD INTENSITY OF RADIO WAVE, COSMIC RAY, SOLAR PHENOMENA AND OTHER RELATED PHENOMENA
June 29-30, July 23-24, 1953
Science Council of Japan, Ionosphere Research Committee, Ueno Park, Japan
Catalogue 17

The reports of the simultaneous observations of typical disturbances in the various elements are summarized in this series. Subjects treated are ionosphere, geomagnetism, field intensity of radio wave, solar phenomena, cosmic ray, and other related phenomena. The results of observations of two remarkable disturbances in 1953 are reported. (Source abstract)

1,002 THE DESCENT OF AN EARTH-SATELLITE THROUGH THE UPPER ATMOSPHERE
King-Hele, D. G.
August, 1956
Royal Aircraft Establishment, Great Britain
TM-G.W. 277; (ASTIA AD-109,523)

A theoretical study is made of the flight path of an uncontrolled but aerodynamically stable satellite as it spirals down through the earth's atmosphere from an initially circular orbit under the action of air drag. The earth and its atmosphere are taken as spherically symmetrical. For altitudes above about 125 nm a simple solution is found: the velocity of the satellite is independent of its size, shape, weight, and initial altitude and is equal to the orbital velocity appropriate to its current altitude, while its angle of descent, in radians, is twice its drag/weight ratio. Estimates of lifetime are also made. (Source abstract)

1,003 LIFETIME OF ARTIFICIAL SATELLITES OF THE EARTH
Henry, I. G.
1956
Aerojet-General Corp., Azusa, Calif.
(ASTIA AD-121,220)

The lifetime of an artificial satellite is calculated on the basis of general assumptions. The satellite is assumed to start in an elliptical, nearly circular, orbit having a radius of about 4500 mi and a radial oscillation of ± 250 mi. The mean height is presented as a function of the rotational energy only. The drag is computed by assuming that all molecules approach the satellite with a uniform relative velocity of 8×10^5 cm/sec and rebound with a zero relative velocity. The atmospheric density is calculated as Ke^{-h/h_c}, where $K = 7.7 \times 10^{-10}$ g/cm^3, $h_c = 14.5$ mi, and h = height above the earth's surface. The height lost per turn and the calculated variation of y with x are used to obtain the lifetime of the satellite; x is given by h_0/h_c and y is given by a/h_c, where h_0 is the mean height of the satellite and a is the amplitude of the variation of the satellite from the mean height. The analysis is limited by present ignorance of the properties of the upper atmosphere. (ASTIA abstract)

1,004 SKIN TEMPERATURE VARIATION DURING RE-ENTRY OF SCIENTIFIC SATELLITE
Masson, D. J.
March 30, 1956
Rand Corp., Santa Monica, Calif.
Research Memo No. RM-1693; Proj. RAND; AF 33(038)6413;
(ASTIA AD-108,748)

The skin temperature variations during the descent of the scientific satellite from its orbit have been computed for 20- and 30-in.-diameter spheres. The skin materials used in these computations were beryllium and aluminum. Since the skin of the satellite will be very thin (low heat capacitance), the computations also give the maximum temperatures of other skin materials. The skin temperatures at the stagnation point of a nonspinning sphere and the average temperature of a spinning sphere were computed. This gave the upper and lower limits of skin temperature to be expected. The scientific satellite, as presently contemplated, has a diameter of 20 in. Skin materials considered for it are magnesium-thorium, beryllium, and aluminum. The skin temperature of such a satellite, during the descent from its orbit into the earth's atmosphere, reaches the melting point of these materials for both spinning and nonspinning 20-in.-diameter spheres. The maximum temperature on the skin is, however, for the case of the spinning sphere, below the melting point of some of the Haynes alloys. Hence, from the point of view of destruction by heat, the recovery of a satellite is considered possible. (Source abstract)

1,005 SCIENTIFIC SATELLITE-PAYLOAD CONSIDERATIONS
Augenstein, B. W.
April 8, 1955
Rand Corp., Santa Monica, Calif.
Research Memo No. RM-1459; Proj. RAND; AF 33(038)6413; (ASTIA AD-86, 959)

A preliminary examination has been made of items suitable for inclusion in the payload of a satellite designed for scientific research. Estimates have also been made of the possible weights and power requirements of these items. The performance of a number of payload combinations totaling 100 lb in weight has been investigated for various duty cycles. It is not the intent of this memorandum to present a complete payload design or specification; rather, it suggests what might be accomplished with a limited payload capacity. (Source abstract)

1,006 THE SIXTH INTERNATIONAL ASTRONAUTICAL CONFERENCE—COPENHAGEN
September 15, 1955
Navy Dept., Office of Naval Research, London
TR-ONRL-89-55

A listing is given of the papers presented at the conference. The papers fall into two categories: biological and medical aspects of extra-atmospheric environment, and means of leaving earth. (JPL abstract)

1,007 USE OF AN ARTIFICIAL SATELLITE IN UPPER AIR RESEARCH (Paper presented at the National Meeting of the American Meteorological Society held in New York on January 23, 1956)
Kallman, H. K., and Kellogg, W. W.
February 15, 1956
Rand Corp., Santa Monica, Calif.
P-760

Observations to be made will give a picture of the upper atmosphere varying with time, latitude, and longitude. Fields of study will include atmospheric densities, atmospheric composition, geodetic measurements, meteors, cosmic rays, interaction of the earth's magnetic field and conditions in the ionosphere, sunlight reflection, and ultraviolet and X-ray measurements. Types of data which can be collected by a satellite depend on available weight, power, and such features as auxiliary power supply and attitude stabilization. Only a lightweight transmitter is needed for density and geodetic measurements to be gained from path observations alone; accurate tracking, however, is necessary. Spraying of known gases into the atmosphere can be used to aid tracking by producing visible light trails; spectroscopic observations of the light trails can indicate atmospheric composition. By means of microphones in the skin of the vehicle, the number and force of meteorites and micrometeorites impacting the satellite can be measured. The characteristics of natural meteors can be deduced by the behavior of artificial meteors of known size, density, and velocity which are ejected from the satellite. Magnetometers operating on the principle of nuclear resonance are usable for magnetic studies; in particular, the problem of the generation of electricity in the ionosphere by charged particles carried by winds across the magnetic lines of force can be investigated. The methods used to detect solar radiation and reflection from the earth depend upon the wavelengths of interest; thermo-luminscent phosphor is sensitive to wavelengths less than 1300 Å, and X-ray radiation can be measured by photon counters. Ionospheric research is particularly valuable for communications improvement. (JPL abstract)

1,008 THE MOON ROCKET (Paper presented at the symposium *Earth Satellites as Research Vehicles* held at the Franklin Institute on April 18, 1956)
Clement, G. H.
Revised: May 7, 1956
Rand Corp., Santa Monica, Calif.
P-833

The problem of designing a vehicle to land on the moon is examined. Performance requirements are established and our current capability estimated. Velocities (>34,800 ft/sec), angles of projection, and position angles (measured from the earth-moon axis at 350 mi above the earth's surface) are considered. An example (V = 35,000 ft/sec, angle of projection = about 75 deg, and position angle = 108 deg at 350 mi) is chosen and the deviations permissible for hitting the moon worked out. The variation of the ratio of vehicle gross weight to payload weight with the number of stages (in early 1956, in 1947, and in 1940, according to the state of the rocket art) is determined. In 1956, in order to carry 50 lb of scientific instruments, 50 lb of communication equipment, and about 550 lb of rocket-weight needed to decelerate from 9000 ft/sec to approximately zero at the moon's surface, it is estimated that a rocket vehicle some 15 ft in diameter, 175 ft long, and weighing at take-off approximately 950,000 lb is needed. (JPL abstract)

1,009 SUMMARY SESSION–ASTRONAUTICS SYMPOSIUM
February 18-20, 1957
General Dynamics Corp., Convair Division
Air Force Dept., Air Research and Development Command, Office of Scientific Research, Baltimore, Md.
AFOSR-TR-57-14; (ASTIA AD-120,430)

A transcript of the recording taken at a summary session of the Astronautics Symposium is given, together with lists of panel members and their report topics in each of the following fields: re-entry, tracking and communications, environment and measurements, propulsion, orbits, and human factors. (JPL abstract)

1,010 DISPERSION IN THE UPPER ATMOSPHERE
Rapp, R. R., and Edinger, J. G.
February 7, 1957
Rand Corp., Santa Monica, Calif.
P-1019

Transosonde balloon data are analyzed to provide a measure of the dispersion on a large scale in the upper atmosphere. An expression for the autocorrelation function is inferred from synoptic experience and is applied to autocorrelation values computed from the balloon data. Taylor's theorem is applied to this function to compute dispersion out to 10 days. A comparison is made with direct computation at 2 days. Limitations of the technique lie in (1) the assumption that the winds are blowing on a plane surface rather than spherical, (2) the fact that statistics were accumulated only in the temperature latitudes for 4 months over a small portion of the northern hemisphere, (3) the assumption made in Taylor's theorem that standard deviation of the wind is constant along the trajectory, although the atmospheric motions cannot be represented by strictly stationary time series, and (4) the failure to consider that cross-correlations may have introduced unknown errors into the dispersion estimates. Nonetheless, a usable estimate is offered. (JPL abstract)

1,011 PROPERTIES OF THE ATMOSPHERE AND IONOSPHERE BETWEEN 90 AND 300 KM
Kallman, H. K.
April 16, 1957
Rand Corp., Santa Monica, Calif.
P-1023

Recent results of experimental and theoretical studies of high-altitude research are presented. The region of investigation covers the height between 90 and 300 km and thus includes the ionosphere. The study is based primarily on a new model of the atmosphere derived from rocket observations as well as on the Chapman theory of ionized layer formation. The results show that the ionosphere does not consist of ionized layers but rather of continuously densely ionized regions. It is also shown that the true height of reflection of radio waves is considerably lower than the apparent height. (Source abstract)

1,012 THE EFFECT OF THE EARTH'S OBLATENESS ON THE ORBIT OF A NEAR SATELLITE
King-Hele, D. G., and Gilmore, D. M. C.
October, 1957
Royal Aircraft Establishment, Great Britain
TN-G.W. 475

The equations of motion of a satellite in an orbit over an oblate earth *in vacuo* are solved analytically by a perturbation method. The solution applies primarily to orbits for which the maximum and minimum altitudes of the satellite do not differ by more than 300 nm; the accuracy of the solution for radial distance should then be about 0.001% and the error in angular travel about 0.001% per revolution.

The earth's oblateness has four main effects on the motion; these effects and numerical values for a mean orbital altitude of 200 nm are:

1. The orbital plane rotates about the earth's axis at a rate of about 8 cos α deg per day (α = inclination of the orbital to the equatorial plane).
2. The period of revolution of the satellite is about 14 $\sin^2 \alpha$ sec greater for an inclined orbit than for an equatorial orbit.
3. The radial distance r from the earth's center changes, the mean r for a given angular momentum being some 13 nm greater for a polar orbit than for an equatorial orbit. During each revolution r oscillates twice, the amplitude being 0.9 $\sin^2 \alpha$ nm under simple conditions.
4. The major axis of orbit rotates in the orbital plane at a rate of about $4(5 \cos^2 \alpha - 1)$ deg per day, rotating with the satellite if $\alpha < 63.4$ deg, or in the opposite direction if $\alpha > 63.4$ deg.

The effect of varying the mean orbital altitude is also considered. (JPL abstract)

1,013 **PRELIMINARY ORBIT INFORMATION FOR USSR SATELLITES ALPHA ONE AND ALPHA TWO**
Schilling, G. F., and Sterne, T. E.
October 14, 1957
Smithsonian Institution, Astrophysical Observatory, Cambridge, Mass.
Special Report 1

Some information released by Moscow is given, together with reports from other sources concerning preliminary orbit information on the Russian Sputnik I and its rocket carrier. (JPL abstract)

1,014 **METHODS AND RESULTS OF UPPER ATMOSPHERE RESEARCH**
Kaplan, J., Kallman, H. K., and Schilling, G. F.
November 30, 1954
University of California at Los Angeles, Institute of Geophysics
SR-3 AF 19(604)-111; (ASTIA AD-56,279)

Methods of investigation are classified according to sources of information: gun shell explosions, rocket observations, high-level balloons, noctilucent clouds, meteor observations, emissions from the sky, propagation of sound waves, propagation of radio waves, searchlight measurements, and theoretical studies. Each method is described and typical results are given concerning temperature, pressure, density, composition, and wind systems. Emphasis is placed on the distinction between results which came from direct measurements and results derived by methods using hypotheses without observations to prove the necesary assumptions. Literature references are presented for each method. (JPL abstract)

1,015 **ORBIT MEASUREMENTS OF AN ARTIFICIAL EARTH SATELLITE (SPUTNIK II) FROM PHOTOGRAPHS TAKEN WITH A TRACKING BALLISTIC TELESCOPE SYSTEM**
Reuyl, D.
November, 1957
Army Dept., Aberdeen Proving Ground, Md., Ballistic Research Laboratories
TN-1156

A brief résumé is given of optical methods for the measurement of artificial earth satellites. Observations of the third-stage rocket of Sputnik I and Sputnik II with tracking ballistic telescope systems, based on SMT and IGOR instruments, are described. Measurements were made of Sputnik II records obtained with the SMT system during the dawn passage on November 7, 1957. The accuracy of the resulting azimuth and elevation values is given by a mean error of about 10 sec of arc for a single observation or 4 sec of arc for the weighted means of all observations. (Source abstract)

1,016 **LIFETIME OF SPHERICAL SATELLITES**
Fields, S.
August 21, 1957
Army Dept., Army Ballistic Missile Agency, Huntsville, Ala., Physics and Astrophysics Section
R-DV-TN-75; RPO-P-TN-14

The numerical calculation of satellite lifetimes was carried out by the ABMA Computation Laboratory on an IBM 704 computer. Figures give the following information: curves of the lifetime of spherical satellites vs perigee altitude (with excess velocity over circular velocity at perigee as a parameter), and perigee and apogee curves with the radial distance from the center of the earth and altitude above the surface of the earth plotted against total revoluions. (JPL abstract)

1,017 **THE LITERATURE OF SPACE SCIENCE AND EXPLORATION**
Benton, M., ed.
September, 1958
(Period covered: 1903-June, 1958)
Navy Dept., Naval Research Lab., Washington, D.C.
Bibliography 13

The 2,274 entries are divided into chronological groups, and the entries in each group are arranged alphabetically by author or issuing agency. An exhaustive list of published unclassified material available in books and periodicals is presented, together with a less complete list of research reports. A complete coverage is given the Vanguard program, and references relating to the Russian Sputniks and the U.S. Explorers are included. (JPL abstract)

1,018 **THE USSR EARTH SATELLITE PROJECT FOR THE INTERNATIONAL GEOPHYSICAL YEAR**
July, 1956
National Defence Dept., Canada, Defence Research Board, Directorate of Scientific Intelligence
R-8/56; (ASTIA AD-107,628)

A review is presented of information on Soviet developments and plans which appeared in Russian newspapers and radio broadcasts as well as technical and scientific journals following the announcement in August 1955 of the Soviet intention to launch a satellite for IGY. Information is presented on the following topics: the International Geophysical Year, plans for high-altitude observations by rockets and artificial satellites, the USSR satellite project, choice of orbit for the Soviet satellite, guidance problems, tracking methods, and instrumentation and telemetering. A chart is included that compares circular orbit velocity and orbit period against altitude. Some reference to progress in other countries, including the US, is made. (JPL abstract)

1,019 **SEARCH FOR SMALL EARTH SATELLITES**
Tombaugh, C. W.
October 1, 1956
(Period covered: 1953-1956)
New Mexico College of Agriculture and Mechanic Arts, Physical Science Laboratory
Interim Report; Project 5B99-01-004 (Army); OOR-1072-P and 1602-P; TB2-0001; DA-04-495-ORD-727 (DA-04-495-ORD-521 with Lowell Observatory); (ASTIA AD-107,843)

Since 1953, Army Ordnance, Flagstaff, Arizona, has sponsored a search for small natural satellites. Objects thought to be satellites have been investigated by means of photographs; thus far, none of the investigated objects has proved to be a satellite.

The basic principle of the satellite search is to drive an equatorially mounted Schmidt camera at a rate to conform with the apparent angular speed of the supposed satellite. The image of such a body is then concentrated to a point image in a very short trail; stellar background is removed.

Another principle employed is *declination offset.* The exposure is broken into two sets of images by means of a quick, small offset in declination near mid-exposure. Breaking the exposure into two unequal parts provides a means of confirming the object's existence and determining its distance. These methods could be used to track artificial satellites. (JPL abstract)

1,020 PHOTOGRAPHIC TRACKING OF AN EARTH SATELLITE
Tombaugh, C. W., and Smith, B. A.
April 10, 1956
New Mexico State College, College of Agricultural and Mechanic Arts, Physical Science Laboratory
Project TB2-0001; DA-04-495-ORD-727; (ASTIA AD-94 423)

This report investigates the possibilities and limitations of photographic tracking of an earth satellite. The conclusion reached is that photographic tracking definitely has its place in artificial-satellite instrumentation, including the launching phase.

For orbital computations, photographic tracking will yield data of greater accuracy than electronic methods. It has also been found that the latitude of photographic tracking is sufficient to cover a partial or complete failure in the launching phase and to supply accurate trajectory data for the determination of the reasons for failure. (JPL abstract)

1,021 THE INTERNATIONAL GEOPHYSICAL YEAR
Hulbert, E. O.
November 10, 1955
(Period covered: June, 1957-December, 1958)
Navy Dept., Naval Research Laboratories, Washington, D.C.

Experiments to be conducted by the United States during the International Geophysical Year (June, 1957, through December 1958) are discussed. Nine panels of the US Committee for the IGY deal with various areas of geophysics (meteorology, geomagnetism, aurora and air-glow, ionosphere, solar activity, cosmic rays, longitude and latitude, glaciology, and oceanography). Three special panels deal with world days, rockets, and the antarctic. (JPL abstract)

1,022 CHARACTERISTICS OF A SATELLITE PATH
October 12, 1955
Army Dept., Redstone Arsenal, Huntsville, Ala., Guided Missile Development Division, Aeroballistics Laboratory,
Flight Mechanics Section Aeroballistics Internal Note-78

Information is given concerning mechanical problems which arise frequently in connection with the orbiting of a satellite. The recurring problems are to find, as functions of arbitrary initial conditions, characteristics of the elliptical flight such as (1) altitude at apogee and perigee, (2) the range of these points from the initial point measured as distance from the surface of the earth, (3) the angle of elevation of the path direction above the local horizontal, (4) the period of the elliptical motion, and (5) the time taken from the initial point to the next apogee.

To solve such problems, formulas are first developed. Whenever feasible, the initial conditions themselves are placed directly in the equations, and the formulas are presented in terms of nondimensional quantities. The equations for elliptical motion are quoted without derivation. Graphs are provided which are useful in

1,026 **EQUATIONS OF MOTION OF SATELLITE IN UPPER REGION OF EARTH'S ATMOSPHERE**
Lundquist, C. A.
April 18, 1955
Redstone Arsenal, Huntsville, Ala.
Rept. No. 6M64; (ASTIA AD-105,883)

The possibility exists that in the first attempts to establish an artificial satellite of the earth the satellite may not attain orbital altitudes such that the air resistance due to the earth's atmosphere is completely negligible. On the other hand, in order to study the properties of the atmosphere at these altitudes, a satellite may be intentionally established at altitudes such that the air resistance is small but appreciable. These possibilities motivate a study of the orbits of an earth satellite which spends at least part of each revolution at altitudes at which the air resistance is appreciable. This discussion is a preliminary effort to such a study. In particular, for certain assumptions about the air resistance, the differential equations of motion of a satellite will be exhibited. The analytical solution of these equations is not easy, but they should be quite easily handled by a large computing machine. Certain conclusions will also be reached from the form of the differential equations and without the necessity of a complete solution. (Source abstract)

1,027 **ADVANCES IN THE PHYSICS OF THE UPPER AIR SINCE 1950**
Hulbert, E. O.
October 25, 1955
Navy Dept., Naval Research Laboratory, Washington, D.C., Office of Naval Research
NRL-R-4600; (ASTIA AD-77,444)

Since 1950, important data have been obtained by means of instrumented rockets. Vertical distribution of atmospheric density was measured to 219 km, of pressure to 130 km, of ozone to 70 km, and of electron density to 219 km. In a day flight, O_2,O,N_2, and N were observed from 98 to 137 km; O_2 was 60% dissociated at from 110 to 128 km. The ratio of argon to molecular nitrogen was about the same at 110 to 137 km as at ground level. Ions of O^+, CN^+, NO^+, and O_2^+ were observed at from 94 to 124 km. At night, only N_2^+ was recorded at from 97 to 114 km. Above 100 km, solar radiation was photographed to 970 Å and recorded by photocells from 100 Å to 6 Å. At 2090 Å, energy decreased, and absorption gave way to emission lines. Theories were worked out for (1) ozone formation, (2) temperature maximum due to ultraviolet absorption by ozone, (3) the aurora, based on magnetically self-focused proton streams from the sun, and (4) the formation of the D, E, and F_2 regions in the ionosphere. From observed ionospheric change over two solar cycles, the solar intensity in wavelengths which causes E, F_1, and F_2 was calculated to increase by a factor of about 2.3 from sunspot minimum to maximum. A model atmosphere was drawn up and extrapolated to 500 km. Better spectra and better analyses of spectra removed much confusion about the auroral spectrum. (JPL abstract)

1,028 **SCIENTIFIC OBJECTIVES AND OBSERVING METHODS FOR A MINIMUM ARTIFICIAL EARTH SATELLITE**
deBey, L. G., Berning, W. W., *et al*
October, 1955
Army Dept., Ballistic Research Laboratories, Aberdeen Proving Ground, Md.
BRL Report 956; Project No. TB3-0538; (ASTIA AD-78,570)

The problems of systematic and accurate observations of a proposed minimum earth satellite have been studied. Limitations imposed by scientific objectives of a satellite vehicle, size of the vehicle, kinds of orbits possible, existing instrumentation technology, and the suitability of instrumentation sites have been considered. It is concluded that a combination of optical and electronic observing methods is required to satisfy the program objectives. Moreover, such a combination appears to be compatible with the imposed limitations. Included are a number of appendixes giving details on the quantitative information appearing in the text as well as supporting information for extension of the various analyses where desired by the reader. (Source abstract)

1,029 **AN EVALUATION OF SOME SATELLITE POWER SUPPLIES**
Cummerow, R. L.
October 17, 1957
National Carbon Research Laboratories, Parma, Ohio
TM-300

The following power supplies were evaluated: photovoltaic solar converters, solar thermopiles, electrical energy generated through the expansion of a gas into the surrounding vacuum, silicon p-n junctions used with radionuclides, high-efficiency thermopiles used with radionuclides, and electrochemical sources of the primary type. This survey has shown that with a moderate amount of development two different types of power supplies give promise of producing superior performance for earth-satellite use. These are the silicon solar converter with miniaturized nickel-cadmium cells and the Po^{210} thermopile made with semiconducting thermoelements. (JPL abstract)

1,030 **MISSILES, ROCKETS AND SATELLITES, VOLUME V: EARTH SATELLITES AND SPACE EXPLORATION**
June, 1958
(Period covered: 1957-March, 1958)
Army Dept., Adjutant General's Office, Washington, D.C.
Pamphlet 70-5-5

This bibliographical survey contains information obtained from periodicals, books, and studies. The survey is divided into two sections, *Earth Satellites* and *Space Exploration*. The *Earth Satellites* section is divided into trends and developments, including scientific and technical data, satellite applications, symposia, bibliographies, historical aspects, miscellaneous aspects, Project Vanguard, Explorer, Pied Piper, and Project Orbiter. The *Space Exploration* section is divided into general aspects, new developments, moon exploration, space stations, space ships (including propulsion and navigation), environmental and medical aspects, space law, symposia, conferences, and bibliographies. (JPL abstract)

1,031 THE DETERMINATION OF THE ORBIT OF 1958 ALPHA AT THE VANGUARD COMPUTING CENTER
Siry, J. W.
May 1, 1958
National Academy of Sciences Conference on 1958 Alpha, Washington, D.C.

Primary reliance for acquisition of data concerning the IGY satellites is placed on the system maintained by the Naval Research Laboratory. This system comprises the Minitrack network, high-speed communication facilities, Vanguard control center, and Vanguard computing center. If no Minitrack signals are received, visual acquisition methods are employed. The radio transmitter in Explorer I is compatible with Minitrack receiving. At the time this report was written the signals had been picked up by Minitrack for 2 months.

The rough orbit (termed elliptic or circular) programs and the precise orbit programs are described. There are two principal types of rough orbit programs: one is designed for observations which are neighboring in a Taylor series sense; the other is designed to use observations, one or more of which are widely separated from the next, in this same sense. There are also two types of precise orbit programs used at the Vanguard computing center. They employ the method of numerical integration and the method of general perturbations. The method of numerical integration is superior from an accuracy standpoint. The elliptic orbit programs can serve three purposes: (1) furnish initial estimates of key parameters for approximate elliptical orbits, (2) furnish initial conditions for numerical integration, and (3) provide checks of the more precise orbit determination programs. A detailed account is given of the process of orbit determination from the time the first sets of observations come to the computing center. (JPL abstract)

1,032 THEORY OF THE MOTION OF ARTIFICIAL SATELLITES II
Kopal, Z.
March, 1958
University of Wisconsin, Madison, Mathematics Research Center Technical Summary R-23; DA-11-022-ORD-2059

A method of formulating the potential of a fluid configuration subject to an arbitrary field of force, previously used to obtain explicit results pertaining to the earth correct to quantities of the first order in superficial distortion, is here extended to quantities of second order in the surface harmonics $Y_j^i\,(a, \theta, \phi)$. Such terms arise from rotational distortion and influence satellite motion. (JPL abstract)

1,033 **REPORT ON VISIT TO THE CSAGI SATELLITE AND ROCKET CONFERENCE, WASHINGTON**
Blackband, W. T.
December, 1957
Royal Aircraft Establishment, Great Britain
TN-RAD.708

An account is given of the CSAGI Conference at Washington D.C. (September 20 to October 5, 1957), and the reports circulated at the conference are listed. (JPL abstract)

1,034 **SOME FLIGHT CONTROL PROBLEMS OF A CIRCUM-NAVIGATING LUNAR VEHICLE**
Xenakis, G.
March, 1958
Air Force Dept., Air Research and Development Command, Wright Air Development Center, Ohio
WADC-TN-58-82; Project 1365-13541; (ASTIA AD-151,111)

Some problems of flight control for a vehicle required to pass around the moon and return to braking ellipse in the earth's atmosphere are investigated. It is shown that reliability will be an extreme problem for this mission. The need for velocity vector control for the mission is established, and a method for accomplishing it is presented. In addition, velocity vector tolerances for successful recapture are investigated along with some brief considerations of landing at a preselected earth site and of flight in nonterrestrial atmosphere. (Source abstract)

1,035 **PROJECT SPACE TRACK: THE ORBITAL MOTION OF THE EARTH SATELLITE 1957 BETA FROM 1 APRIL 1958 TO ITS DECAY 14 APRIL 1958**
Miczaika, G. R., and Wahl, E. W.
June 5, 1958
Air Force Cambridge Research Center, Mass.,
Geophysics Research Directorate
AFCRC-TN-58-445; (ASTIA AD-152, 621)

The orbital motion of the Russian artificial earth satellite 1957 Beta between 1 April 1958 and 14 April 1958, the day of its disintegration, is discussed. The analysis is based on all positional observations available to Project Space Track prior to 22 May 1958. These observations are listed in a catalog. Included in the study are descriptive reports on the decay phenomena as observed from ships and islands in the Caribbean Sea. Notes on the decay of the Russian satellite 1957 Alpha, written in December 1957, are added as a matter of record. (Source abstract)

1,036 **DRAFT: MANUAL ON THE IGY ROCKET AND SATELLITE PROGRAMS**
Berkner, L. V., *et al*
August 15, 1957
National Academy of Sciences, National Research Council, US National Committee for the IGY, Washington, D.C.

The manual is divided into two parts, one concerned with the planned rocket program, the other concerned with the planned satellite program. The first section is further divided according to the country performing the experiments, and the contributions of Australia, Canada, France, Japan, the USSR, the United Kingdom, and the US are detailed. The US pre-IGY rocket program is presented in an appendix. The second section is divided into general satellite considerations, the US IGY satellite program, the USSR IGY satellite program, and the programs of other countries participating in IGY satellite research.

1,037 **ON THE LUNAR DUST LAYER**
Whipple, F. L. (Smithsonian Institution, Astrophysical Observatory, Cambridge, Mass.)
April 29, 1958
Data Publications, Washington, D.C.
2 ASTRO-12

From observations of the moon made optically in the infrared by radio and by radar it is concluded that the moon's surface consists of a thin insulating layer overlying denser material, producing a surface that is a very poor reflector at all frequencies so far observed. At dimensions comparable to the wavelength of light, the surface is almost completely rough; but it is relatively smooth at wavelengths and dimensions comparable to 10 cm. The moon's surface is subjected to bombardment by meteoritic material and corpuscular radiation (protons) and to a slow rain of dust, molecules, atoms, and ions as a consequence of the meteoritic bombardment. It is concluded that these processes coupled with solar radiation will tend to cement the dust into a weak, semiporous matrix and that no appreciable quantity of loose dust will be found on the moon's surface. The surface material should not blow badly in a rocket jet and should be sufficiently rigid for support of the normal structures and operations required of the lunar expedition. (Source abstract)

1,038 **THEORY OF THE SPIN OF A CONDUCTING SATELLITE IN NON-EQUATORIAL ORBITS**
Vinti, J. P.
October, 1957
Army Dept., Ballistic Research Laboratories, Aberdeen Proving Ground, Md.
R-1031

The theory of the spin of a conducting spherical satellite affected by earth's magnetic fields for orbits which are precessing circles is simplified by smoothing out the high-frequency fluctuations at the start, in the differential equations. Two special cases are considered: (1) with a polar orbit, if the spin is not initially parallel to the equatorial plane, the smoothed spin eventually approaches perpendicularity; (2) in the case of an orbit with inclination 41.268 deg, if the spin is not initially perpendicular to the equatorial plane, the smoothed spin ultimately becomes parallel to this plane. The longitude angle of the smoothed spin for this inclination is shown to be a quasiperiodic function of time, the secular rate being 0.0428 deg per day westward for a 500-mi altitude of a magnesium satellite at 20°C. (Source abstract)

1,039 MISSILES, ROCKETS AND SATELLITES, VOLUME IV: TECHNOLOGY MEANS AND METHODS
June 16, 1958
Army Dept., Adjutant General's Office, Washington, D.C.
Pamphlet 70-5-4

This bibliographic survey covers the period 1957 through March 1958 and includes almost 1,500 unclassified titles, partly abstracted and annotated, and selected from periodicals, books, and studies. This volume contains references to means and methods of technology. It includes such subjects as accessory power, aerodynamics, computers, electronics, fuels, ground support and handling, guidance, heat problems, launching, materials, orbits, and recovery and re-entry. (JPL abstract)

1,040 MISSILES, ROCKETS AND SATELLITES, VOLUME III: GREAT BRITAIN, FRANCE AND OTHER FREE COUNTRIES OF THE WORLD
June 16, 1958
Army Dept., Adjutant General's Office, Washington, D.C.
Pamphlet 70-5-3

This bibliographic survey covers the period 1957 through March 1958 and includes almost 1,500 unclassified titles, partly abstracted and annotated, and selected from periodicals, books, and studies. References are included from the following: Australia, Canada, France, Germany, Great Britain, Italy, Japan, Sweden, and NATO. The following British missiles are treated: Bloodhound, Bobbin, Fireflash, Firestreak, Seaslug, Skylark, and Spectre. (JPL abstract)

1,041 **MISSILES, ROCKETS, AND SATELLITES, VOLUME II: UNITED STATES**
June 16, 1958
Army Dept., Adjutant General's Office, Washington, D.C.
Pamphlet 70-5-2

This bibliographic survey covers the period 1957 through March 1958 and includes almost 1,500 unclassified titles, partly abstracted and annotated, and selected from periodicals, books, and studies. This volume covers material relating to the missile program of the US as well as to the launching of Vanguard and Explorer. (JPL abstract)

1,042 **MISSILES, ROCKET AND SATELLITES, VOLUME I: USSR**
June 16, 1958
Army Dept., Adjutant General's Office, Washington, D.C.
Pamphlet 70-5-1

This bibliographic survey covers the period 1957 through March 1958 and includes almost 1,500 unclassified titles, partly abstracted and annotated, and selected from periodicals, books, and studies. This volume contains references to most of the available unclassified materials on the activities of the USSR, including Soviet missile diplomacy, missile programs, and Sputniks. (JPL abstract)

1,043 **INTERNATIONAL GEOPHYSICAL YEAR (A Special Report prepared by the National Academy of Sciences for the Committee on Appropriations of the United States Senate)**
Hayden, C.
May 28, 1956
National Academy of Sciences, Washington, D.C.
Document-124 (Special Report)

This report presents the scientific programs now planned by the US as well as a brief synopsis of activities to date in connection with the IGY. The fields of interest discussed are meteorology, oceanography, glaciology, the upper atmosphere, ionospheric physics, aurora and airglow, geomagnetism, cosmic rays, earth's crust and core, seismology, gravity measurements, latitude and longitude determinations, and rockets and satellites. (JPL abstract)

1,044 **ADDITIONAL ORBIT INFORMATION FOR USSR SATELLITES 1957 ALPHA ONE AND BETA ONE**
Rinehart, J. S., and Schilling, G. F.
November 5, 1957
Smithsonian Institution, Astrophysical Observatory, Cambridge, Mass.
Special Report 2

Preliminary orbital information was collected in an earlier report. The present report expands and brings up to date the material which can be judged to be of immediate interest to co-workers involved in problems of orbit analysis. The tentative system of notation identifies each satellite by the year of its launching, followed by a letter of the Greek alphabet, to indicate successive order of launching. A number follows the Greek letter in inverse sequence of brightness; the brightness component shall be $\alpha 1$, the next brightest $\alpha 2$, etc. (Source abstract)

1,045 **SOVIET ORBIT PREDICTIONS AND ORBITAL INFORMATION FOR USSR SATELLITES 1957 ALPHA ONE, ALPHA TWO, AND BETA**
Schilling, G. F., and Ferguson, E. S.
December 4, 1957
Smithsonian Institution, Astrophysical Observatory, Cambridge, Mass.
Special Report 5

The present report continues the collection and presentation of orbital information released by the USSR. Consecutive tables list Soviet predictions of satellite passages over or near world points, as received at the Astrophysical Observatory. Pertinent data on orbital characteristics are summarized in tabular form, classified for different parameters. (Source abstract)

1,046 **RADIO OBSERVATIONS ON THE RUSSIAN SATELLITE AT REDSTONE ARSENAL**
Norman, J. E.
October 31, 1957
Army Dept., Redstone Arsenal, Huntsville, Ala., Ordnance Missile Laboratories
R-2M1F

Observations of the radio signals emitted by the Russian satellite during the period 5 October to 10 October are reported. Signals were received on 40.002 mc by a Hallicrafter SX-62A receiver and on 20.005 mc by a National HRO-60 receiver. Separate single-wire antennas of the order of 200 ft in length were used. Independent observation on 20.005 mc was made by the Redstone Military Affiliate Radio System. Audio signals were fed to separate channels of a cathode-ray oscilloscope, and a number of photographs of waveforms were made, some of which are presented in the report. Notable observations include (1) a sinusoidal modulation envelope of about 5 sec per cycle duration, perhaps arising from the use of a dipole antenna on the satellite in rotation rate of about 10 sec per revolution, (2) an alternation in tone between 20 and 40 mc, suggesting that the antennas for the two wavelengths might be mutually perpendicular, and the irregularity of pulse shape, particularly the frequent apparent splitting at mid-point, suggesting purposeful modulation and information transmittal. (JPL abstract)

1,047 LAUNCHING OF SPACE VEHICLES BY AIR-BREATHING, LIFTING STAGES
Ferri, A. Brooklyn (Polytechnic Institute), Nucci, F. M., Daskin, W., and Feldman, F. (Gruen Applied Science Laboratories, Hempstead, N. Y.)
April 29, 1958
Data Publications, Washington, D.C.
2 ASTRO-8

The advantages of a lifting airplane used as the first stage of a satellite launching system are listed as follows: increased specific impulse, variable launching site, usability for a variety of satellites, elimination of need for large and expensive ground installations, reusability of the first stage, and higher reliability of the first stage. The problem is then considered of placing a 10,000-lb package in orbit, the payload being of the order of 7,500 lb. The launching vehicle is assumed to be a conventional swept- or delta-wing configuration. The airplane trajectory to launch, the path angle for various engine-size values, the engine performance data assumed in the analysis, the problems of heating and high drag, the centrifugal force corrections, fuel consumption, and component weights are all considered using standard parameters. It is concluded that the problem can be resolved by using 150,000-lb-thrust rockets and supersonic aircraft; the inherent path angle for aircraft rocket launch goes down with increasing M; but as the launch speed is increased beyond $M = 4$, the airframe disadvantages outweigh the disadvantages of large rocket engines. (JPL abstract)

1,048 VISUAL OBSERVATIONS OF ALPHA ONE MADE BY MOONWATCH STATIONS DURING LIFETIME OF THE ORBIT
Campbell, L. Jr., and Hynek, J. A.
December 17, 1957
Smithsonian Institution, Astrophysical Observatory, Cambridge, Mass.
Special Report 6

In this report, the observation techniques, uses of observations, and early history of the Moonwatch operation are briefly reviewed. The chronological listing of all significant observations of 1957 Alpha makes up the bulk of the report. Some few observations of Alpha Two are included. The successive columns give date of observation, station name and number, geographical station location, component of Alpha observed, time of observation in UT, right ascension of azimuth, declination or altitude, direction of motion, angular velocity, magnitude, and color of object. During the eight-week life of 1957 Alpha, 131 teams contributed a total of 391 observations. (JPL abstract)

1,049 STATUS REPORTS ON OPTICAL OBSERVATIONS OF SATELLITES 1958 ALPHA AND 1958 BETA
Schilling, G. F., ed.
April 30, 1958
Smithsonian Institution, Astrophysical Observatory, Cambridge, Mass.
Special Report 11

The following reports are included: preliminary results from optical tracking of the US earth satellite; the network of precision photographic satellite-tracking stations; Moonwatch observations of satellites 1958 Alpha, 1958 Beta, and 1958 Gamma; the orbit and variable acceleration of 1958 Alpha; the density of the upper atmosphere; life expectancy of 1958 Alpha; use and distribution of satellite predictions; program for determination of geographic subsatellite points; predictions for crossing of given latitude parallels-APO ephemeris 5; predictions for photographic satellite-tracking stations–APO ephemeris 4; program of spot predictions for specific observing sites–APO ephemeris 3; and charts of predicted satellite positions. (JPL abstract)

1,050 OBSERVATIONS ON HEAVY PRIMARY COSMIC RAY NUCLEI ABOVE THE ATMOSPHERE
Yazoda, H.
July, 1958
Air Force Cambridge Research Center, Mass., Geophysics Research Directorate, Geophysical Research Papers 60; (ASTIA AD-152,585)

The flux of heavy primaries of $Z > 6$ has been evaluated from small emulsion blocks flown on Aerobee rockets specially designed to keep condensed matter below 0.2 g–cm^{-2} after penetrating the atmosphere. Parachute recoveries were effected from a day and a night flight, yielding $J_S^\circ = 4.85 \pm 0.95$ and 5.05 ± 0.88 (m^2-sec-sterad.)$^{-1}$, respectively, suggesting the absence of a pronounced day-night effect in the total heavy primary flux. The average for the two Aerobee flights is $J_S^\circ = 4.98 \pm 0.65$ and the M°/H° ratio is 1.91 ± 0.55. This is in good agreement with a Viking rocket flight made in 1954 for which $J_S^\circ = 5.38 \pm 0.58$ and $M^\circ/H^\circ = 2.01 \pm 0.50$ when the omnidirectional fluxes are averaged over the entire zenith angle spread accepted by the emulsions along the rocket trajectories. Balloon observations from the same geomagnetic locality (41°N) yield a vertical flux about 1.61 times greater than the rocket observations, in good agreement with geomagnetic theory which predicts small fluxes at zenith angles greater than 45°. Based on the interactions of L and S-nuclei and their mean free paths in emulsion, the L°/M° ratio is estimated to be 0.26 ± 0.09, which favors a smaller flux of Li-Be-B nuclei at the top of the atmosphere than in most extrapolations of balloon observations. A study of the mode of fragmentation of the heavy primaries suggests that secondary *L*-nuclei are produced more frequently at rocket elevations than in balloon exposures. This altitude variation may be associated with the anomalous cascades observed on the Viking 10 flight. In this flight, secondary *L*-nuclei originating in the fragmentation of primary S-nuclei appear to have collision cross sections greater than geometric. To confirm this, it is proposed that a 12-lb emulsion block be exposed in an Aerobee-Hi rocket. (Source abstract)

1,051 IONOSPHERIC DATA
New Zealand Department of Scientific and Industrial Research, Geophysics Division, Christchurch Geophysical Observatory

This volume, the first of a series, contains ionospheric data for Godley Head, Christchurch, 1955, Rarotonga, Cook Islands, 1955, and Campbell Island, 1954. In the future, data will be published annually in this form. (JPL abstract)

1,052 THE STUDY OF THE UPPER ATMOSPHERE BY MEANS OF ROCKETS, AT THE ACADEMY OF SCIENCES, USSR
Poloskov, S. M., and Mirtov, B. A.
January, 1957
Royal Aircraft Establishment, Great Britain
Translation 626; (ASTIA AD-127,749)

The Academy of Sciences of the USSR has begun a program of direct observation of the upper atmosphere by means of rockets. Experiments carried out to date include the determination of atmospheric composition at altitudes of 80-95 km by collecting air samples in evacuated glass spheres, measuring pressure at altitudes of 50-110 km by the use of pressure gauges, and measuring wind speed and direction at altitudes of 60-80 km by the creation and observation of artificial clouds. The experimental technique is unique in that the measuring instruments are not carried in the rocket itself but in containers ejected from the rocket by special mortars; the results are recorded on film and the containers are recovered by parachute. For the IGY the work will be augmented to cover a wide range of subjects: temperature, pressure, density, movement of the upper atmosphere, the ionosphere, cosmic radiation; the sun's ultraviolet spectrum, micrometeorites, and corpuscular radiation from the sun. (Source abstract)

1,053 GEODETIC APPLICATIONS OF ARTIFICIAL SATELLITES
Johns, R. K. C.
March, 1958
Laboratory for Electronics, Inc., Boston, Mass.

Geodetic investigations present the problem of connecting one set of geodetic data across the ocean or over long continental distances to another set of geodetic values related to different spheroids of reference and having different datum systems. Some existing and feasible methods are discussed. It is assumed that direct triangulation or trilateration is not possible. Astronomic-gravity methods described require a highly qualified astronomer, take considerable field work, and have a precision of I 30 m for geodetic position. Lunar methods include: (1) the lunar camera method, in which the position of the moon on the stellar background is photographed, (2) the moon radar method, and (3) the observation of lunar occultations and eclipses. The accuracy of such methods is not high. The satellite-optical method is limited by visibility. The accuray is not high unless the precision or orbit can be assured. Electronic methods for satellite tracking offer the greatest advantages because: (1) conventional radar techniques are not accurate enough for geodetic work; (2) interferometer methods offer simplicity, but the doppler effect and the effect of plumb deflection on measured angle lessen accuracy; (3) electronic distance measurement offers the greatest accuracy, being unaffected by plumb deflections, only slightly affected by refraction, and not related to any coordinate system, position of the earth's center of gravity, or the earth's axis of rotation. Electronic distance measurement is explained fully in the report and its accuracy estimated. (JPL abstract)

1,054 ASTRONOMICAL PHENOMENA FOR THE YEAR 1960
Navy Dept., Naval Observatory, Nautical Almanac Office, Washington, D.C.

The material presented is in part a preprint of selected pages from the *American Ephemeris and Nautical Almanac.* Universal Time schedule is used. Included are tables of the time of moonrise and moonset, sunrise and sunset, beginning and end of astronomical twilight, eclipses of the sun and moon, planetary configurations, phases of the moon, and morning and evening stars. Additional information concerning calendars and chronological cycles is included.

1,055 THE ATMOSPHERES OF THE PLANETS (Presented at the Symposium on *The Atmospheres of the Stars and Planets*)
Herzberg, G.
June, 1950
National Research Council, Canada
NRC 2279

A review is given of the present status of spectroscopic investigations of planetary atmospheres, including that of the earth. In the case of the earth's atmosphere the recent discovery by Meinel of OH in the spectrum of the night sky is discussed and its importance for the phenomena in the upper atmosphere is pointed out. The spectroscopic detection of CO_2 in the atmospheres of Venus and Mars is described in some detail, and laboratory investigations aiming at more accurate determinations of CO_2 content, pressure, and temperature in these atmospheres are discussed. The observations of CH_4 absorption bands in the major planets and the satellite Titan are summarized, and the possibility of detecting molecular hydrogen by means of a quadrupole rotation-vibration spectrum is outlined. It is probable that one of the unidentified features in the spectrum of Uranus and Neptune is due to the 3-0 band of the pressure-induced rotation-vibration spectrum of H_2. (Source abstract)

1,056 SOME PRELIMINARY VALUES OF UPPER ATMOSPHERE DENSITY FROM OBSERVATIONS OF USSR SATELLITES
Stern, T. E., and Schilling, G. F.
November 15, 1957
Smithsonian Institution, Astrophysical Observatory, Cambridge, Mass.
Special Report 3

On the basis of available orbital data for the USSR satellites 1957 Alpha One, Alpha Two, and Beta One, preliminary values of atmospheric density have been calculated for the respective perigee altitudes. The computations necessarily involve a number of speculative assumptions with regard to mass-area ratios, but the results show a reasonable consistency in numerical values derived from the three satellites independently.

It would appear that the atmospheric density at altitudes between 220 and 230 km is somewhat higher than has often been assumed. While the values derived here must be considered as being of an extremely tentative nature, it is expected that similar methods of calculation will, in the future, permit the inference of atmospheric density over a wide range of altitudes from orbital data. (Source abstract)

1,057 OPTICAL SATELLITE TRACKING PROGRAM: THE DESCENT OF SATELLITE 1957 BETA ONE
Jacchia, L. G.
Smithsonian Institution, Astrophysical Observatory, Cambridge, Mass.
Special Report 15

This report presents the author's analysis of observations of the final descent of the second Soviet earth satellite. It is based on on-the-spot interviews with persons who witnessed the descending flight path over the Caribbean Sea, on observations from the northeastern US, and on observations from ships at sea. Numerical integrations for a set of orbital trajectories are reported. The paper is essentially an extension of Special Report No. 13 and covers the end part of the last revolution of satellite 1957 Beta. The tables include observational data and the most probable descent trajectory from 101 km MSL to impact. (JPL abstract)

1,058 UPPER ATMOSPHERE DENSITIES FROM MINITRACK OBSERVATIONS ON SPUTNIK I
Harris, I., and Jastrow, R.
September 2, 1958
Navy Department, Naval Research Laboratory, Washington, D. C., Nucleonics Division

Analysis of Minitrack data on 1957 Alpha Two provides information on the density of the atmosphere above the perigee altitude of 232 km. With allowance for the estimated probable errors in the density at 200 km and for the uncertainty in the orbit elements and ballistic drag parameter of Alpha Two, the data still yield a relatively unambiguous determination of density up to 400 km. The calculations are based on a ballistic drag parameter of $89 \pm 9\ kg/m^2$. The same comparison is made with densities of the ARDC atmosphere. (JPL abstract)

1,059 AN INTERIM ATMOSPHERE DERIVED FROM ROCKET AND SATELLITE DATA
Harris, I., and Jastrow, R.
1958
Navy Department, Naval Research Laboratory, Washington, D.C., Nucleonics Division

Information obtained from US and USSR satellites on density and temperature of the atmosphere at high altitudes is combined with data obtained from rocket flights below 200 km to construct a model atmosphere which yields a relatively unambiguous determination of density up to 400 km. Analysis of satellite data is based on orbital elements obtained from Minitrack observations, particularly on the rate of change of the orbital period, which is dependent upon the drag of the atmosphere. Detailed numerical integrations may be used in solution as the satellite decreases altitude and period. Adiabatic approximations to the equations of motion have also been developed, and details of the derivation are given in an appendix. Error in these approximate results for 1957 Alpha Two during 80% of the satellite lifetime is less than 2%. Apogee and perigee altitudes during the lifetime of this satellite computed by both methods, model atmospheres calculated from several satellites, scale height distributions assumed in constructing atmospheres, and a survey of lifetimes for a satellite with a certain ballistic drag parameter are all represented graphically. (JPL abstract)

1,060 ASSUME A CAPABILITY FOR MANNED SPACE OPERATIONS. FOR WHAT PURPOSES SHOULD THIS CAPABILITY BE UTILIZED?
Spilhaus, A., University of Minnesota, Minneapolis Institute of Technology
April 29, 1958
Data Publications, Washington, D.C.
2 ASTRO-6

The usefulness of man's seeing and hearing abilities in observing the universe is considered. It is shown that, except for studies of the behavior of man and biological organisms in vehicles in space and the actual exploration of bodies in space, unmanned instrumented vehicles will continue to be more economical than manned vehicles. For most interplanetary investigations (e.g., those concerning photons, particles, and gravitational and magnetic fields), instruments are more effective than human senses. There is much reason to believe that further advances in communications will continuously cut down the degradation of information. Another factor supporting the use of instrumentation is that any number of persons specialized in the interlocking fields may observe telemetered data and direct the observational program of the space vehicle. (JPL abstract)

1,061 **SATELLITE 1958 DELTA ONE (the weekly predictions of the orbit for satellite 1958 Delta one)**
Predictions dated September 30, 1958, *et seq* as received
Smithsonian Institution, Astrophysical Observatory, Cambridge, Mass.

1,062 **THE IGY OPTICAL SATELLITE TRACKING PROGRAM AS A SOURCE OF GEODETIC INFORMATION**
Whipple, F. L., and Hynek, J. A.
1958
Smithsonian Institution, Astrophysical Observatory, Cambridge, Mass.

The three parts of the optical tracking program are discussed: visual search and acquisition, photographic tracking, and the computation and analysis center. The photographic precision program will use 12 Baker-Nunn satellite tracking cameras and associated Norrman crystal clocks. The telescopes should photograph 50-cm spheres to a distance of 2500 km or more and 6-m spheres to the moon's distance. The measures can be used according to the two basic principles of effective triangulation and gravitational effects. The successful achievement of geodetic objectives will depend to a large extent on the ability to determine exact satellite orbit and orbit variations by means of high-speed computing machines. The computational program will be one of successive approximations. It is hoped that a very sensitive criterion of the distribution of mass in the earth, particularly the density distribution in the crustal volumes, will be achieved. (JPL abstract)

1,063 **PROBLEMS OF COSMICAL AERODYNAMICS (Proceedings of the Symposium on the Motion of Gaseous Masses of Cosmical Dimensions held in Paris, August 16-19, 1949)**
May 20, 1958
International Union of Theoretical and Applied Mechanics

Discussions are presented of the general subjects of interstellar gas, magnetic fields and magneto-hydrodynamic waves, aerodynamic equations, heating, shock waves, specific novae and theory of novae, turbulence, spiral structure of gaseous masses, and galaxies.

The papers presented at the symposium and printed in the report, together with their authors, include: *Problems of Interstellar Gas Clouds,* B. Stromgern; *Physical Properties of the Interstellar Gas,* L. Spitzer, Jr.; *Electromagnetic Phenomena in the Motion of Gaseous Masses of Cosmical Dimensions,* H. Alfvén; *Interstellar Polarization and Magneto-Hydrodynamic Waves,* H. C. van de Hulst; *Aerodynamical Description of Elementary Expansion Phenomena and Shock*

Waves, J. M. Burgers; *The Expansion of an Interstellar Gas Cloud into a Vacuum*, G. C. McVittie; *Physical Problems of High-Altitude Flight*, R. J. Seeger; *The Collision of an Expanding Shell of Gas with an Interstellar Cloud*, H. A. Kluyver; *The Heating of the Solar Chromosphere by Shock Waves and Related Problems*, E. Schatzman; *The Properties of a Shock Wave in a Gas with Decreasing Density*, J. M. Burgers; *The Nova Phenomenon*, C. Payne-Gaposchkin; *The Shell of Nova Aquilae 1918*, H. C. van de Hulst; *Interaction of Nova and Supernova Shells with the Interstellar Medium*, J. H. Oort; *Introductory Remarks on Turbulence*, Th. von Karman; *Magnetic Fields and Turbulence in a Fluid of High Conductivity*, G. K. Batchelor; *Turbulence in Interstellar Matter*, C. F. Von Weizsacker; *Distribution and Motions of Gaseous Masses in Spirals*, W. Baade and N. U. Mayall; *On the Motion of Dark Clouds in Galaxies and Some Related Problems*, B. Lindblad; *The Origin of the Rotations of the Galaxies*, F. Hoyle; *Morphology of Large Scale Aggregations of Matter in the Universe*, F. Zwicky; *Hydrodynamic Problems Connected With the Solar Atmosphere*, M. Minnaert.

Group discussions, some of which discuss the specific papers listed above, are also included. Discussions of more general subjects include: *Discussion on the Physical State of the Interstellar Gas*, Chairman, A. Danjon; *Discussion on the Existence and Uniqueness or Multiplicity of Solutions of the Aerodynamical Equations*, Chairman, J. von Neumann; *Discussion on Shock Waves in the Interstellar Gas and in the Chromosphere*, Chairman, G. Temple; *Discussion on Interstellar Magnetic Fields*, Chairman, B. Lindblad; *Discussion on the Importance of Compressibility and Gravitation for the Turbulence in the Interstellar Gas*, Chairman, H. Mineur; *Discussion on the Influence of Magnetic Fields on Turbulence*, Chairman, H. Mineur.

An introduction by J. H. Oort and a summary of the symposium by J. M. Burgers are also presented. (JPL abstract)

1,064 A THEORY OF NIGHTLY AND HIBERNAL ANABIOSIS OF THE ULTRAXEROPHYTIC FLORA AND POSSIBLE SYMBIONTIC FAUNA ON MARS
Pereira, F. A.
1958
Brazil, Brazilian Interplanetary Society (SIB), Scientific Council

The views obtained from a survey of the literature concerning vegetable or animal life on Mars are discussed. The possibility of anabiosis (a reduction of metabolical intensity to the threshold of biochemical processes) during evening and winter climates is raised. Large daily and seasonal changes in Martian temperature and humidity make anabiosis in the afternoons and at the end of fall likely. (JPL abstract) of balloon observations. A study of the mode of fragmentation of the heavy primaries suggests that secondary *L*-nuclei are produced more frequently at rocket elevations than in balloon exposures. This altitude variation may be associated with the anomalous cascades observed on the Viking 10 flight. In this flight, secondary *L*-nuclei originating in the fragmentation of primary S-nuclei appear to have collision cross sections greater than geometric. To confirm this, it is proposed that a 12-lb emulsion block be exposed in an Aerobee-Hi rocket. (Source abstract)

1,065 STUDIES IN SOLAR-GEOMAGNETIC RELATIONS: OPTICAL CRITERIA
Hansen, R. T., Warwick, C. S., *et al*
May 12, 1958
Commerce Dept., National Bureau of Standards, Boulder Laboratories, Boulder, Colorado
R-5570, Part I

The "superposed epoch" or Chree method of statistical analysis is used to investigate the relation between geomagnetic activity and a given type of solar event; the method is described, as is the computing procedure. Tests of the significance of deviations of Ap (the geomagnetic index) and of frequence of high Ap values are explained. The studies have been divided into four groups, those dealing with solar flares, with corona, with prominences, and with various indexes of active regions. Flares of classes 3, 2, and 1, and limb flares are considered; some results are graphed and flare indexes established. The intensity of the green coronal line has been investigated and results graphed, and the active regions with and without green coronal maximum are considered. The coronal yellow line, the coronal loop prominences, and downward-flowing prominences are also discussed. The "disparitions brusques," or sudden disappearances of filaments, have been studied, but unfortunately there are few observations of the most dramatic type, the ascending (eruptive) filaments. The fluctuating plages associated with sudden disappearances have also been investigated. The various active-region indexes include the HAO activity index, the Meudon active-region index, IAU active regions with at least 5 flares, and the HAO regional flare index. (JPL abstract)

1,066 USE OF V-2 ROCKET TO CONVEY PRIMATE TO UPPER ATMOSPHERE
Simons, D. G.
May, 1949
Air Materiel Command, Wright-Patterson AFB, Ohio
TR 5821

The techniques and devices developed to protect a monkey during flight in the nose section of a V-2 rocket are described. The results obtained from two separate flights are discussed. During both flights, the animal, properly supported, was enclosed in a pressurized capsule containing a 24-hr oxygen supply and apparatus for carbon dioxide and water-vapor absorption. Provisions for recording respiration and heart action during the flight on a Cook recorder tape were also included. A parachute system was expected to return the nose section to the ground intact; however, neither time did it operate properly. Cook recorder tapes were recovered in both instances. The records show no physiological activity on the first tape, but on the second flight the animal was still alive throughout 340 sec and up to a few sec before impact. Appendixes make up the bulk of the report; Appendix A, design and construction of components, explains the pressurized capsule, animal support, oxygen supply, and elimination of CO_2 and H_2O, as well as recording instruments; Appendix B explains final preparations and results for the two flights. (JPL abstract)

1,067 **CATALOGUE OF DATA IN IGY WORLD DATA CENTER A: AIRGLOW AND IONOSPHERE (Archive 1 of 11)**
July 15, 1958
Commerce Dept., National Bureau of Standards, Central Radio Propagation Laboratory, Boulder, Colo.

This catalogue lists records and data on file at the US IGY World Data Center A for airglow and ionosphere. It includes material received through July 1, 1958 and supersedes the catalogue of April 15, 1958. (Source abstract)

1,068 **OPTICAL SATELLITE TRACKING PROGRAM: POSITIONS OF SATELLITE 1957 BETA ONE DURING THE FIRST 100 REVOLUTIONS**
Adams, R. M., and Briggs, R. E.
July 25, 1958
Smithsonian Institution, Astrophysical Observatory, Cambridge, Mass.
Special Report 16

Latitudes, longitudes, and heights are tabulated for the position of satellite 1957 Beta One for the period during which the radio was transmitting. No claim is made for high precision, since the accuracy is limited by that of the observations (reported in Special Report 13) and by the neglect of periodic perturbations of magnitude comparable to the scatter in observations. Secular perturbations have been taken into account. A time interval of 5 min is used. The first position given is for November 3, 1957 at 0600 (GMT). However, positions prior to November 4, 1957 at 0700 (GMT) are extrapolations of later observations. Longitudes are given in degrees east. Heights are in kilometers from the subsatellite points (intersections of radius vectors with the geoid). (JPL abstract)

1,069 EXPLORER I: COMPILATION OF THE MORE IMPORTANT CONGRATULATORY MESSAGES RECEIVED BY GENERAL MEDARIS AND DR. VON BRAUN ON THE OCCASION OF THE LAUNCHING OF EXPLORER I
January 31, 1958
Army Dept., Army Ordnance Missile Command, Army Ballistic Missile Agency, Huntsville, Ala.

1,070 RADIATION HAZARDS IN HIGH ALTITUDE AVIATION
Tobias, C. A.
May, 1952
University of California at Berkeley, Donner Laboratory
Medical Physics Division Report RDO-695-72; AD-5

A comprehensive review and summary is given of present knowledge of the hazards of natural radiation at high altitudes. The physical aspects of cosmic radiation are dealt with. The probable duration of exposure and the distribution of different types of radiation are stated. The following subjects are considered: cosmic rays between 0 and 70,000 ft altitude, neutrons in the atmosphere, ionization from cosmic-ray nuclei, energy transfer from cosmic-ray nuclei, estimation of distribution of the dose in the heavy nuclei, and experimental facilities available for testing effects due to high rate of energy loss. A discussion of the biological effects of cosmic radiation is divided into two sections, lightly ionizing components and highly ionizing particles. An appraisal of health hazards is given which pertains to the general hazard from heavy nuclei and contains possible special effects of cosmic radiation such as cataracts, bone tumor, leukemia, and genetic damage. A discussion is made of the planning and coordination of biological tests. It is concluded that even in extensive high-altitude flying the hazard would be slight in comparison with ordinary dangers from artificial sources. (JPL abstract)

1,071 SOLAR-COSMIC EFFECTS ON FEBRUARY 23-25, 1956 OBSERVED BY THE IONOSPHERIC SOUNDINGS NETWORK
Shapely, A. H., and Knecht, R. W.
August 15, 1958
Commerce Dept., National Bureau of Standards, Boulder Laboratories, Boulder, Colo.
R-5596

Vertical soundings from more than 18 ionospheric stations in the northern hemisphere indicate the geographic extent and character of the outstanding increase in ionization of the lower ionosphere beginning in the dark hemisphere of the earth following the great solar outburst and cosmic-ray flux increase of

February 23, 1956. From an index of absorption of high-frequency radio waves based on the lowest frequency at which ionospheric echoes were recorded by routine sweep frequency ionosondes, the ionospheric event is first detected about 20 min after the start of the flare and about 10 min after the beginning of the cosmic ray event. The earliest effect is at stations near the geomagnetic pole, and in general its beginning is systematically later and apparently slower at lower geomagnetic latitudes down to about 60 deg, without an obvious dependence on local time. At subauroral latitudes the absorption increase begins at the ensuing sunrise as an increment to the normal solar-controlled absorption. The index shows no effect for stations below about 50 deg geomagnetic latitude. Absorption remained high for 40 or more hours at intra-auroral stations, while magnetic activity continued relatively calm until a severe storm began abruptly some 47 hours after the solar flare.

Soundings from the daylight hemisphere show the familiar flare-associated absorption increase, attributed to excess solar electromagnetic radiation. In addition, Okinawa measurements are suggestive of a flare-associated increase of 17% in F2-layer maximum electron density, an effect not apparent, however, at other daylight stations. (Source abstract)

1,072 HOW HIGH THE MOON?
Furnas, C. C., (University of Buffalo, N.Y.)
April 28, 1958
Data Publications, Washington, D.C.
2 ASTRO-4

It is conceded that man will explore space, and the expense of the program is considered. Four questions are asked: (1) Will the public support the program? (2) Can continuing support be justified? (3) What organization pattern should there be? (4) What will be the longtime results?

Tentative answers are given to these questions. It is pointed out that the most appealing idea from a longtime view is the acquisition of new basic knowledge to be applied in the future as opportunity arises. (JPL abstract)

1,073 REPORT OF THE AGEE COMMITTEE ON GEODETIC APPLICATIONS OF ARTIFICIAL SATELLITES
O'Keefe, J. A.
May, 1958
American Geophysical Union, Section of Geodesy, Committee on Geodetic Applications of Artificial Satellites, Washington, D.C.

An introductory explanation by J. A. O'Keefe, Chairman, is followed by statements by seven other members of the committee: S. W. Henriksen, Army Map

Service; D. Lambert, Ohio State University; J. O'Sullivan, Jr., NACA; H. Schmid, G. Simmons, Coast and Geodetic Survey; R. K. C. Johns, Laboratory for Electronics; and C. A. Lundquist, ABMA.

Geodetic information to be gained from satellite investigations bears on the following areas: (1) the flattening of the earth, (2) the semimajor axis, (3) regional gravity anomalies; (4) geodetic positioning in remote areas. The technical difficulties of such measurements are considered. O'Keefe notes that the requisite theory for determining the flattening of the earth from the motion of the modes of 1957 Beta presents four theoretical difficulties: (1) the motion of the modes depends somewhat on the fourth harmonic of the gravitational field as well as on the flattening of the earth; (2) the motion depends on the square of the flattening as well as the first power; (3) the motion depends on the cosine of the inclination (severe for 1957 Beta); and (4) the motion depends on the period (varying at nonconstant rate in 1957 Beta). Atmospheric drag enters considerably into the nonconstant period variation, and a higher satellite may eliminate this important problem.

Henriksen explains the result of the nonsphericity of the earth. By two mathematical methods, second-order differential equations for satellite motion are solved to yield a value for J (the coefficient of the second-order Legendre polynomial) best reproducing the observed motions of the mode and perigee. A value for the flattening is obtained from J.

Lambert considers the gravitational forces on the moon and on a satellite.

O'Sullivan considers the effects of air density on satellite motion. A small, high-density satellite equipped with a flashing light and low-power transmitter is suggested.

Schmid considers the accuracy of orbit determination of a satellite usable for geodetic purposes.

Simmons considers the limitations on perigee position and orbit form for a satellite obtaining data on the earth's anomalous gravitational field. Some sort of transponder on a satellite for observing its distance by a Shoran type of equipment is suggested.

Johns considers the choice of tracking techniques: reflecting or transmitting, angular or distance measurements, optical or microwave methods. A detailed outline summarizes the various elements requiring consideration in all tracking methods.

Lundquist mentions that, in the course of events, higher perigees are likely to be forthcoming, and further attention might be turned toward data-reduction methods in preference to orbit optimization, from a geodetic standpoint. Simultaneous optical observation from widely separated points is suggested. (JPL abstract)

1,074 **FURTHER DATA ON RADAR RETURNS FROM AURORA AT 488 MC/S**
Blevis, B. C., and Cameron, E. A.
July, 1958
Defense Research Telecommunications Establishment, Canada, Communications Wing
CW-R-44-2-2

An extension is reported of previously presented (Chapman, *et al*, January, 1958) information on auroral radar observations at a frequency of 488 mc. The measurements, though of some value, are preliminary in nature and limited by weak visual auroral displays. The transmitter is located near Ottawa, Ontario; the receiver is located near Meath, Ontario, about 100 km from the transmitter. The equipment is described, block diagrams being given for the two systems. The doppler spectrum of the returned signal is displayed on a Marconi spectrum analyzer of 30-cps filter bandwidth, 10-sec sweeptime, $\pm$4-kc sweep width, and 4-mc sweep center frequency. A two-channel Tektronix 545 oscilloscope is used for *A*-scans. A number of photographs of the spectrum analyzer and *A*-scan displays are reproduced. Echoes have been recorded some 3 or 4 db above noise at frequencies as far removed as $\pm$4 kc from the carrier frequency. In the future, more data will be collected at this frequency, and a simultaneous study will be made at 944 mc. (JPL abstract)

1,075 **SATELLITE 1958 EPSILON (The weekly predictions of the orbit for satellite 1958 Epsilon)**
Predictions dated October 14, 1958 *et seq* as received
Smithsonian Institution, Astrophysical Observatory, Cambridge, Mass.

1,076 **COSMIC RAY INSTRUMENTATION IN THE FIRST U.S. SATELLITE**
Ludwig, G. H.
March, 1958
State University of Iowa, Physics Dept.
SUI 58-4; Proj. U.S./I.G.Y. 32.1

A detailed description is given of the cosmic-ray instrumentation which was flown in the first US satellite, Explorer I. The complete payload package of scientific instruments in satellite 1958 Alpha is outlined in block form. Schematics are given of various circuits and wave forms produced. A thick-walled, halogen-quenched, Geiger-Mueller tube was selected for its reliability. Pulses from the tube are first scaled by a factor of 32. Rectangular pulses frequency-modulate two channel-five subcarrier audio-oscillators through direct-coupled emitter-follower circuits. Changes of state of this output scaler shift the frequencies of the oscillators discontinuously between two chosen values. The driver circuit, scalers, and output emitter followers as well as the waveforms produced are described in detail. The high-voltage power supply is a push-pull square-wave oscillator with a transformer voltage step-up ratio of approximately 35, a voltage quadrupler, and a corona discharge regulator tube. The selection of components is explained. (JPL abstract)

1,077 **SATELLITE 1958 ALPHA (The weekly publications of the orbit for satellite 1958 Alpha)**
Predictions dated September 30, 1958 *et seq* as received Smithsonian Institution, Astrophysical Observatory,
Cambridge, Mass.

1,078 **OBSERVATION OF HIGH INTENSITY RADIATION BY SATELLITES 1958 ALPHA AND GAMMA**
Van Allen, J. A., Ludwig, G. H., *et al*
May, 1958
State University of Iowa, Physics Dept.
SUI 58-5; Proj. U.S./I.G.Y. 32.1

A preliminary report is presented of results obtained concerning radiation intensities measured with a single Geiger-Mueller tube carried by satellites 1958 Alpha and 1958 Gamma. Data from nine entire orbits of 1958 Gamma had been reduced in a preliminary fashion when the report was written. The data were transmitted continuously from 1958 Alpha and recorded only when the satellite was near a station. The data collected by 1958 Gamma were also telemetered continuously, but, in addition, a small magnetic-tape recorder stored the data for an entire orbit and read out on radio command the stored data when near a station. The instrumentation and circuitry are explained fully. Graphs are presented, representing height vs counting rate near the California coast for 1958 Alpha, height vs geographic latitude in the vicinity of 75°W longitude, geographic latitude vs geographic longitude for various orbits of both satellites, scaler output from 1958 Gamma as a function of time, and counts per sec with dead-time effects vs those without dead-time effects. The data are interpreted and the implications are considered. In particular, the extremely low output rate of the scaler at certain heights is believed to be caused by radiation intense enough to jam the Geiger tube so that it puts out pulses of such small height that they are below the threshold of the counting circuits. Other explanations are considered and discarded. Experiments upholding the "high-intensity jamming" theory are reported. This high-intensity radiation is thought to be composed of either protons or electrons. (JPL abstract)

1,079 SOVIET SPACE EFFORT: ORGANIZATION, EQUIPMENT, OBJECTIVES, AND PERSONNEL
Kudravetz, G. K.
May 12, 1958
(Period covered: 1954-1957)
Air Technical Intelligence Center, Wright-Patterson AFB, Ohio
IR-1375-58

A comprehensive report is presented of official information on the Soviet space effort released up to 1958 and obtained from 68 open sources. The following subjects are discussed: the general program; high-altitude research rockets; animals in rocket research; the launching, orbit, construction, and instrumentation of Sputnik I; the orbit, construction, and instrumentation of Sputnik II; the passenger in Sputnik II; transmission of information by Sputniks; reception of signals; monitoring procedure; submission of data; the visual observation program; future plans regarding power supply; propulsion, launching methods, re-entry methods, and motion in space; the Soviet space timetable; general research projects; the organization of Soviet space effort; personnel in the Soviet space effort; and references.

A few of the Soviet ideas for future use are mentioned here; solar energy in photoelectric, thermoelectric, and molecular dissociation effects is suggested for future power supply; photonic rockets are briefly considered. Aircraft first stages and jettisonable turbojet engines are suggested for launching. Recovery of instruments may be accomplished by metal-sphere containers inflated by helium gas and acting as parachutes, braking rockets, or glide-wings. The use of planetary gravitational fields and ballistic motion of the space ship instead of fuel for interplanetary travel is recommended. (JPL abstract)

1,080 HIGH ALTITUDE OBSERVATORY
Warwick, J. W.
April 30, 1958
(Period covered: October 1—December 31, 1957)
University of Colorado, High Altitude Observatory
Scientific R-10; AF 19(604)-1491; (ASTIA AD-152,362)

Preliminary results are presented of analyses of our 20-mc radio observations of Russian satellites 1957 Alpha Two and 1957 Beta One. Equipment built under this contract for studies of ionospheric absorption and refraction in the range of 15 to 20 mc was virtually the only gear in the Western world immediately available without modification of any sort for detailed tracking and recording of the signals from Sputnik I. For this reason, the records include interferometer passages from as early as 0500 UT on October 5, 1957, within a very few revolutions of the time of launching, and detailed study has been given the problem of reduction of tracking information from these records, taken with a simple interferometer. This problem, with preliminary results, occupies Section I of the report.

Section II contains a catalogue of the various types of ionospheric fading and peculiar interferometric effects that the Russian satellites produced. Only a preliminary and descriptive interpretation of most of these phenomena is presented.

Section III presents an analysis of the most basic fading shown on the records, which is fading produced by the spinning of Sputnik I on an axis contained within itself. (The spin of Sputnik II was not observed sufficiently long for an adequate analysis.) Since this spinning appears in all the records as a fundamental and strictly periodic effect, analysis of the spin-fading necessarily precedes analysis of the other ionospheric types of fading that also appear on the records. A secular change is identified in the spin-fading rate that occurred over the three weeks of observation of Sputnik I. It seems natural to identify the effect with atmospheric drag. If this is done, a means of independently determining atmospheric density at the perigee point of the satellite is available. Therefore, details of the analysis of this effect and the resulting density value are presented. Finally, details on the spin-fading characteristics of rotating, circularly polarized antenna systems are presented.

The final section of the report is a bibliography and annotation for the preceding sections. (Source abstract)

1,081 **PHOTOGRAPHIC TRIANGULATION, A Precise Method for Tracking Artificial Satellites**
Wakabayashi, I., and Kirmser, P. G.
July 12, 1958
Kansas State College
Preliminary Report; Project-262

The disadvantages of conventional methods of astronomy for tracking artificial satellites are briefly discussed. A short comparison is given of triangulation with the other data-reduction techniques of radar, *stadia,* and doppler shift. Chapter II, entitled *Obtaining Data for Triangulation,* includes discussion of the minimum requirements, the organization and orientation of stations, and pre-aiming and synchronization. Chapter III, *Theory of Triangulation,* explains analytic solutions and graphical solutions using gnomic projection. Chapter IV, *The Effects of the Earth's Rotation,* includes (1) the relationship between celestial and geocentric spherical coordinate systems, (2) timing markers, determination of camera orientation, and coding, and (3) a comparison of triangulations using fixed cameras and right ascension drives. Satellite coordinates and relationships to earth coordinates together with tracking and predictions by local groups are considered in Chapter V, *Tracking and Prediction.* (JPL abstract)

1,082 **OPTICAL SATELLITE TRACKING PROGRAM: REPORTS AND ANALYSIS OF SATELLITE OBSERVATIONS**
July 15, 1958
Smithsonian Institution, Astrophysical Observatory, Cambridge, Mass.
Special Report 14

A table of Moonwatch observations is presented which includes observation number, station name and number, time of observation, stellar coordinates, and magnitude. A discussion is presented of the status of the photographic satellite tracking system. Tables are presented on limiting magnitude data of the Baker-Nunn Camera #1 at the New Mexico station, an estimate of positional accuracy with the Baker-Nunn cameras, and resolution characteristics of these cameras. The timing of satellite observations is discussed, and the crystal clock is explained. The mass-area ratios of satellites 1958 Delta One and Delta Two are determined in a preliminary manner; the ratio is needed in order to use reasonable values of the ballistic drag parameter in orbit predictions. A list of other issues in the Special Report Series and related publications of the Smithsonian Astrophysical Observatory, together with the availability of these issues, is presented. (JPL abstract)

1,083 **EXPLORER I**
February 28, 1958
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
External Publication No. 461

A history of the development of Explorer I is given. The launching system is described. A description is given of the satellite and of the experiments conducted in the satellite. The experiments induced temperature measurements, the measurement of micrometeorite impact, and the measurement of cosmic-ray intensity. Launching mechanics and orbit choice are also discussed. (JPL abstract)

1,084 **NOTES ON PROJECT DEAL**
Hibbs, A. R.
March 14, 1958
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
External Publication No. 471

The Army Explorer satellites carry instrumentation approved by the National Committee for the IGY as part of the earth-satellite program. The satellites are launched by a Jupiter C type of vehicle, developed jointly by the Army Ballistic Missile Agency (ABMA) and the Jet Propulsion Laboratory (JPL); these facilities are described. A description is given of the Jupiter C launching vehicle and the satellites. The data reduction and analysis process for Explorer I is outlined. Orbit determination responsibilities are given. (JPL abstract)

1,085 BALLISTICS OF THE EXPLORER
Froehlich, J. E., and Hibbs, A. R.
April 1, 1958
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
External Publication No. 478

A discussion is presented of the trajectories used in launching the satellites Explorers I and III. Particular attention is given to the problems involved in the optimization of these trajectories with regard to payload weight and lifetime. The lifetimes of the Explorer experiments are directly proportional to the weight of the batteries that power the radio transmitters. On the other hand, the lifetimes of the orbits are functions of the launching altitude and speed, and therefore depend inversely on the total battery weight. Another important consideration in selecting lifetimes is the fact that there are certain inaccuracies inherent in the launching of these satellites. Sources of trajectory errors are derived and discussed. Consideration is given to the choice of both thrust and spin rate for the high-speed stages. A probabilistic analysis of trajectory errors is then used to determine optimum launching conditions, and the criteria used to establish these conditions are discussed at length. Finally, the results of the two satellite firings are reviewed and compared with predicted orbits. (Source abstract)

1,086 TELEMETERING THE EXPLORER SATELLITE
Koukol, J.
August 14, 1958
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
External Publication No. 487

The information obtained from Explorer I concerned: (1) space environment, (2) the effectiveness of new temperature control techniques in the alternately torrid and frigid temperature extremes encountered in outer space, and (3) the performance of an advanced communication system. The technical aspects of the telemetering equipment are given. Special emphasis is given to the data-processing problems. Results show that space environment appears to offer no insurmountable hazards to humans. From preliminary data reduction it appears that cosmic-ray activity is about 8 times greater than on the surface of the earth. Micrometeorite particles appear to be a minor hazard. Temperature extremes encountered by the satellite exterior shell varied from about 167°F when the satellite was in sunlight to 14°F when it passed through the earth's shadow. Interior temperature varied from 113 to 32°F over a period of 6 weeks. (JPL abstract)

1,087 SATELLITE ENVIRONMENT VIA ONE-MILLIWATT OSCILLATORS
Riddle, F. M.
May 7, 1958
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
External Publication No. 502

Two things are important in the instrumentation of space vehicles: (1) telemetering must be economical of weight, and (2) it must transmit data for a long time. Current telemetering practice (including transistorized systems) fails to meet the performance required by 2 to 4 orders of magnitude. This paper discusses circuit design philosophy and practical circuits using fractions of a milliwatt per measurement in systems requiring no filters and a minimum of other components. Circuit design is centered around energy-storage passive (inductance and capacitance) devices rather than dissipative resistors, thereby obtaining maximum power efficiency. The active elements are transistors used at very low power levels. Two basic circuits allow the measurement of all the common physical parameters, and a third circuit measures voltage. Some of these circuits have been used in Explorer I and subsequent Army satellites with excellent results. (Source abstract)

1,088 TERMINAL GUIDANCE OF A LUNAR PROBE
Gates, C. R.
May 14, 1958
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
External Publication No. 506

The guidance of a vehicle to a soft landing on the moon has been examined. It is concluded that guidance in two stages (lateral guidance at a point some 5,000 mi above the earth's surface using optical and inertial instruments as error sensors, and braking along the path near the surface of the moon using a radio altimeter as an error sensor) is feasible. Existing components and techniques are adequate to perform these functions; aside from weight reduction, no new developments are needed. (Source abstract)

1,089 PRELIMINARY REPORT ON THE INSTRUMENTATION AND OPERATION OF THE EXPLORER SATELLITES
Richter, H. L., Jr.
June 20, 1958
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
External Publication No. 523

The instrumentation carried in the satellites 1958 Alpha and 1958 Gamma is described. The 1958 Alpha, designated Explorer I, was designed primarily to make environmental measurements; 1958 Gamma, designated Explorer III, made measurements of the total cosmic flux present outside the earth's atmosphere. The results of preliminary analyses of data received from these satellites are presented as announced by the responsible institutions. (Source abstract)

1,090 SCIENTIFIC MEASUREMENTS BY EXPLORERS I AND III
Buwalda, J., and Hibbs, A. R.
August 1, 1958
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
External Publication No. 538

The instrumentation carried by Explorers I and III provided for measurement of shell and internal temperatures, micrometeorite activity, and cosmic-ray intensity. The purpose of the temperature measurements was to verify the predictions of temperature environment which were made during the design phase of the payload development. The results of this design study indicated that adequate temperature control could be achieved simply by coating a certain fraction of the stainless steel case of the satellite with a suitable material (in this case a ceramic aluminum oxide). Approximately 25% of the cylindrical section of the case and 30% of the nose section were covered with this ceramic material in a pattern of longitudinal stripes. Examination of the telemetered data from the satellite has given the following results: temperatures on various parts of the shell range between −25 and +75°C; temperatures inside the cylindrical section range from 0 to 35°C. Explorer I contained two devices for the measurement of micrometeorite activity. The first device was a microphone mounted against the outer skin of the satellite. The second device, which was also carried on Explorer III, consisted of a set of 12 wire gauges. Micrometeorite impact was very small. More information is needed during a period of meteor showers. Results of the cosmic-ray measurements showed that at altitudes below about 1000 km the counting rate of the Geiger-Mueller tube indicated a cosmic-ray intensity which agreed very well with extrapolations made from experiments with balloons and high-altitude rockets. At altitudes above approximately 100 km, for regions between 30 deg N latitude and 30 deg S latitude, there is an intense field of low-energy electrons. These electrons, with energies varying from around 50 to 90 kev, produced bremsstrahlung on impact with the satellite shell. (JPL abstract)

1,091 FEASIBILITY OF RELATIVISTIC "RED SHIFT" MEASUREMENT USING AN ARTIFICIAL SATELLITE
Wells, W. H.
July 16, 1958
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
External Publication No. 539

A difficulty is pointed out in Singer's proposal that the "red shift" of relativity be measured by comparing an atomic or molecular clock on an artificial satellite to a clock on earth. The difficulty lies in the fact that the atomic clock suffers the same failing, to a smaller degree, that an ordinary clock suffers, namely that its rate depends upon mechanical structures, the cavity, its tuning mechanism, and even connecting waveguides. Two atomic clocks are considered: a maser oscillator and a cesium clock using a conventional oscillator. The sources of inaccuracy are pointed out for both types. For the feasibility of the maser clock, the critical factor in decision is expressed by

$$\frac{\Delta\omega_c}{\omega_c} < \frac{1}{2 \times 10^6}$$

where ω_c is the cavity frequency. The molecular beam in a satellite clock must be shielded from the earth's magnetic field to avoid error due to the Zeeman effect; it is sufficient to reduce the field by a factor of about 30 for Cs and 500 for NH_3. (JPL abstract)

1,092 **PROCESSED OBSERVATIONAL DATA FOR USSR SATELLITES 1957 ALPHA AND 1957 BETA**
Adams, R. M., and McCumber, N.
March 1, 1958
Smithsonian Institution, Astrophysical Observatory, Cambridge, Mass.
Special Report 10

This report presents a collection of observational data, received and processed by the Smithsonian Astrophysical Observatory, for the two Soviet artificial earth satellites launched October 4, 1957 and November 3, 1957 respectively. The data cover the total lifetime of the components Alpha One, Alpha Two, and, probably, Alpha Three from the 1957 Alpha launching. For the second Soviet satellite, 1957 Beta, the data extend from the day of launching to the middle of February, 1958. The tables include, in addition to observation number and station location and number, the time of observation, right ascension, declination, azimuth, angular elevation, and apparent magnitude. The sources and processing of data are also explained. Coordinates for 9004 stations are presented in a separate listing. (JPL abstract)

1,093 **PROJECT RAND: A CASEBOOK ON SOVIET ASTRONAUTICS**
Krieger, F. J.
June 21, 1956
Rand Corp., Santa Monica, Calif.
RM-1760, Part I

This casebook consists of two principal sections. The first is a four-part bibliography dealing with the historical, scientific, and technical aspects of rocketry and astronautics. The second is a series of complete translations from the Russian of articles and papers by various authorities selected from a variety of periodicals.

The titles of the articles are: *The Way to the Stars, Flight to the Moon, Is a Moon Rocket Being Built in the Soviet Union?, Trip to the Moon, Fantasy and Reality, On the Way to the Stars, Problems of Interplanetary Flights, Gold Medal Established for Outstanding Work in the Field of Interplanetary Communications, Problems of Cosmic Flight, Commission on Interplanetary Communications, Problems of Flight into Cosmic Space, Problems of Astronautics, An Artificial Satellite of the Earth, Cosmic Laboratory, The Artificial Earth Satellite, Discovery of a World, Problems of Cosmic Flights, On Flights into Space, The Road into the Cosmos, Problems of Weightlessness,* and a table of Soviet missiles. (JPL abstract)

1,094 OBSERVATIONS OF THE MOON FROM THE MOON'S SURFACE
Kellogg, W. W.
July 27, 1956
Rand Corp., Santa Monica, Calif.
RM-1764; (ASTIA AD-133,007)

An attempt is made to explore the various experiments which could be performed and the various observations which could be made by an unmanned vehicle capable of landing on the surface of the moon. The following experiments are considered: an atomic explosion, measurement of lunar mass and gravity, direct measurement of the lunar magnetic field, mass spectrographic measurements of the lunar atmosphere, pressure and density of the lunar atmosphere, seismic and microseismic observations of the lunar crust, surface radioactivity, lunar atmospheric electricity, temperature of the lunar surface, surface hardness, and chemical and physical analyses of the surface. (JPL abstract)

1,095 ACCURACY REQUIREMENTS FOR TRAJECTORIES IN THE EARTH-MOON SYSTEM (Presented at the Astronautics Symposium, February 19, 1957)
Lieske, H. A.
February 19, 1957
Rand Corp., Santa Monica, Calif.
P-1022

The authors have investigated the accuracy requirements of the initial velocity vector for unpowered, or ballistic-type, vehicles for several typical missions in the earth-moon system. This simple type of vehicle was assumed to be unguided after the vernier stage of the booster operation, and therefore no corrections would be made to the trajectory. For some cases, the vehicle was assumed to be able to add velocity increments to change the type of trajectory it was following, that is, to reduce the approach speed to a safe value for landing on the moon or to establish the body as a satellite of the moon. To hit the moon or to pass near the moon and return to the earth, the accuracy requirements of the initial velocity vector were found to be of the order of 100 ft sec and 1 deg, in magnitude and direction, respectively. (Source abstract)

1,096 **ARTIFICIAL SATELLITES OF THE MOON**
Buchheim, R. W.
June 14, 1956
Rand Corp., Santa Monica, Calif.
P-873

The requirements for establishing artificial satellites of the moon are discussed. The orbit parameters of lunar satellites are considered, and limits are derived for avoiding the final extremes of impact on the moon and recapture by the earth. Sample transit trajectories and moon satellite orbits are presented. Computations of motion are based on an earth-moon model that represents the earth and moon as spheres rotating uniformly about their common center of mass. The problems of attitude stabilization during the earth-moon transit and of velocity adjustment near the moon are considered. Lunar satellite size and mass are related to visual magnitude, and approximate system weight requirements are estimated. (Source abstract)

1,097 **PROJECT RAND: A RECOVERABLE SCIENTIFIC SATELLITE**
Gazley, C. Jr., and Masson, D. J.
December 21, 1956
Rand Corp., Santa Monica, Calif.
RM-1844; (ASTIA AD-112,406)

The uncontrolled descent of a satellite from its orbit involves a less severe heating problem than the re-entry of a long-range ballistic missile because of the more gradual descent and consequent smaller deceleration of the satellite. The satellite descent is slow enough so that the thin skin attains the radiation equilibrium temperature corresponding to a given velocity and altitude. Although the shallow descent alleviates the heating problem somewhat, the location of the impact point is complicated by the nature of the descent. The location of the impact point appears to be the most difficult aspect of a recovery program but can be accomplished by radio tracking and ultimate recovery by means of a radio beacon. (Source abstract)

1,098 ASTRONOMICAL PAPERS PREPARED FOR THE USE OF THE AMERICAN EPHEMERIS AND NAUTICAL ALMANAC: COORDINATES OF VENUS 1800-2000
Herget, P.
March 7, 1955
Navy Dept., Naval Observatory, Washington, D.C., Nautical Almanac Office
Astronomical Papers, Vol. XV, Part III

1,099 ASTRONOMICAL PAPERS PREPARED FOR THE USE OF THE AMERICAN EPHEMERIS AND NAUTICAL ALMANAC: SOLAR COORDINATES 1800-2000
Herget, P.
February 9, 1953
Navy Dept., Naval Observatory, Washington, .D.C., Nautical Almanac Office
Astronomical Papers, Vol. XIV

1,100 ASTRONOMICAL PAPERS PREPARED FOR THE USE OF THE AMERICAN EPHEMERIS AND NAUTICAL ALMANAC: THEORY OF THE ROTATION OF THE EARTH AROUND ITS CENTER OF MASS
Woolard, E. W.
April 13, 1953
Navy Dept., Naval Observatory, Washington, D.C., Nautical Almanac Office
Astronomical Papers, Volume XV, Part I

Formulas previously used for nutation were not accurate enough to justify the precision of computation attempted in determining star locations to the great degree of accuracy needed. In order to revise nutation formulas, the dynamical theory of the motion of the earth about its center of mass has been redeveloped. Revised numerical expressions have been constructed for the nutation. The details of the redevelopment are presented. General kinematical and dynamical equations of rigid motion are included as well as an explanation of precession and nutation of the axis of rotation. The disturbing forces, solution of Poisson's equations, corrections for approximations, lunisolar precession and nutation, and reduction to ecliptic of date and equator of date are all considered in connection with the motion of the axis of rotation. The motion of the axis of figure relative to the axis of rotation, and the angular motion of the earth around the instantaneous axis are also considered. (JPL abstract)

1,101 TRACKING AND COMMUNICATION FOR A MOON ROCKET
Gabler, R. T., and O'Mara, H. R.
April 22, 1957
Rand Corp., Santa Monica, Calif.
P-1021

Certain phases of the overall problem of sending an instrument package to the moon to telemeter scientific information are considered. The specific concern is with tracking the vehicle after it is placed on a proper trajectory and with telemetering information after it lands. It may also be desirable to telemeter information from the instrument package en route, especially if this does not unduly complicate the problem of tracking.

The report is divided into the following chapters: *Tracking Requirements, Telemetering Scheme, Vehicle Antenna, Power Requirements,* and *Weight Estimates.* Three or four tracking stations properly spaced in longitude and with communication links between stations will be required to track the vehicle continuously. Because of the weight and especially because of problems of reliability, the first moon package will probably not carry a transponder, but will carry a crystal-controlled oscillator with power amplifier. This means that angle-only information on position will be available. However, estimates of the requirements for transponding to obtain range are included. Since a CW system is assumed, range is obtained by a phase comparison of a modulation frequency after it has made the round trip to the vehicle and back. The phase difference between the transmitted frequency and the received frequency represents, within a fixed delay, a quantity proportional to range. Several modulation frequencies are generally used to give precise range determination and to reduce ambiguity.

For telemetering, the same crystal-controlled oscillator and power amplifier used for tracking will be employed, with a command receiver switching to control power and to modulate the power amplifier. A simple sequencing switch will enable the command receiver to control power output and also switch to a telemetering function when desired. (JPL abstract)

1,102 A MATHEMATICAL MODEL OF THE GRAVITY FIELD SURROUNDING THE EARTH
Cohen, C. J.
February 15, 1957
Navy Dept., Computation and Exterior Ballistics Laboratory, Naval Proving Ground, Dahlgren, Va.
NPG-R-1514 (NAVORD-R-5135)

In connection with the prediction of trajectories of ballistic missiles and earth satellites, formulas are derived for the gravity field surrounding the nonspherical earth. These formulas are based on the characterization of the free surface of the earth as an oblate spheroid. No further assumptions regarding the mass distribution within the earth are required. Closed-form solutions as well as series expansions are presented for the potential, the force components, and g at the earth's surface. The various constants and coefficients in the expressions are evaluated numerically on the basis of the international conventions for the figure of the earth and for gravity at the equator. (Source abstract)

1,103 DEMISE OF SATELLITES 1957 ALPHA 1 AND 1957 BETA
Harris, I., and Jastrow, R.
Presented in Moscow: Summer 1958
Navy Dept., Naval Research Laboratory, Washington, D.C. Nucleonics Division

This study was made in order to gain a better understanding of atmospheric re-entry. Calculations have been carried out relating to both satellites, based primarily on radar data obtained during the last several days in their lifetimes. Reports of visual observations are also used. The analysis indicates the general need for one or more observations of altitude during the final pass in order to determine impact point. The procedure of analysis involves starting numerical integration of satellite equations of motion prior to re-entry, checking the results with available observations, adjusting the value of drag coefficient to allow for large discrepancies, and repeating the integration. Tables and graphs represent (1) a comparison of observed and calculated positions of 1957 Beta for the June 13 pass over Jodrell Bank, (2) polar projection of the northern hemisphere showing the trajectory of 1957 Alpha One during its final pass, (3) apogee-perigee altitude difference during the final passes of 1957 Alpha One, (4) comparison of observed and calculated altitudes during the final days of 1957 Alpha One, and (5) the trajectory of 1957 Beta during its terminal pass. (JPL abstract)

1,104 ANALYSIS OF LUNAR METHODS IN GEOMETRIC ASTRONOMY
Johns, R. K. C.
July 2, 1958
Laboratory for Electronics, Inc., Boston, Mass.

The applications of lunar observations for determination of the figure of the earth and the establishment of geodetic ties between widely separated nonintervisible stations are discussed. The inherent accuracy of lunar methods is analyzed by means of equations developed herein. The numerical precision of lunar methods is evaluated by the introduction of data regarding the present precision of observations, lunar ephemeris, the existing knowledge of the moon's topography and lunar profile. The conclusions are drawn from the numerical evaluation. Geodetic applications of artificial satellites are indicated. (Source abstract)

1,105 **THE SCIENTIFIC AND ENGINEERING EXPLORATION OF THE MOON**
Barnes, J. L. (Systems Corp. of America, Los Angeles, Calif.)
April 29, 1958
Data Publications, Washington, D.C.
2 ASTRO-10

Short-range study of the moon from vehicles orbiting near it is imminent. From the cost standpoint it is advisable to perform the first experiments near the moon rather than on it. The differences between the moon and man-made satellites are pointed out. Several groups of questions are asked: (1) What is the precise mass distribution of the moon, or what is its precise gravitational force field? (2) Does the moon have a magnetic field of its own? If so, how is it distributed in space, and what are its time variations? (3) Does the moon have an atmosphere of its own distinct from that part of the sun's atmosphere attracted by the moon's gravitational field? If so, what are its composition, density, and temperature? (4) What are the moon's material composition, pressure, and temperature? What are their spacial and time distributions? What is the radioactivity of the moon's surface? Methods for determining answers to these questions are suggested.

The pertinent engineering problems to be resolved by answers to the foregoing questions include: locations for landing, take-off, manned bases, transportation routes, observatories, power-generating plants; sources of water, oxygen, minerals, and road materials; and locations of hazardous regions, such as fissures or deep dust layers.

A few of the reasons for putting bases on the moon are suggested; they relate to astronomical, meteorological, and geocartographical research fields. Once space vehicles actually land on the moon, the experimental range will broaden and will include material study and seismic-wave-transmission experimentation by instrumentation alone and first-hand investigation by human passengers. (JPL abstract)

1,106 **THE UTILIZATION OF A SATELLITE LABORATORY FOR LIFE SCIENCE STUDIES**
Campbell, P. A. (Air Force Office of Scientific Research, Baltimore, Md.)
April 29, 1958
Data Publications, Washington, D.C.
2 ASTRO-5

Two environments are projected by the "satellite laboratory" which are of great interest for life science studies: extended periods of weightlessness (or zero g), and exposure to unattenuated radiation from the cosmos. The former environment and its variation from the usual earth environment are explained carefully. The problems of radiation from the cosmos is mentioned briefly.

Plants on the earth have certain growth patterns. Perhaps gravity is instrumental in growth and nutritional support in plants. Perhaps mutation is affected by gravity changes. It is important to know the effects of gravity changes on plants if algae or large leaf plants are to be used in the gas exchange system for manned flight. Spatial orientation and equilibrium in man are maintained by the visual system, the inner ear, and deep muscle, visceral, and skeletal sensing; of these, the latter two are gravity-oriented. The dynamics of the cardiovascular systems, the energy variation when more is consumed by the g loading, and the fluid dynamics of other parts of the body, such as the urinary bladder, pose other problems. The ability of a man trained to use scientific judgment in observing and reporting such phenomena is likened to "a relatively light weight, low energy consuming, versatile, mobile computer with horse sense." (JPL abstract)

1,107 EXPERIMENTS FROM A LUNAR VEHICLE
Johnson, M. H. (Aeronutronic Systems, Inc., Glendale, Calif.)
April 28, 1958
Data Publications, Washington, D.C.
2 ASTRO-2

Possible experiments from a lunar vehicle are listed. These include trajectory measurements by radar for determining more accurately the gravitational fields of the earth and moon, experiments for verifying impact of the vehicle on the moon, spectrographic analysis of lunar and cis-lunar atmospheres, optical and infrared camera experiments, meteor analysis, ion probes, measurement of the magnetic moment of the moon, and determination of cosmic radiation.

Trajectory experiments are dealt with specifically. Two fundamental astronomical constants can be determined more accurately by trajectories in the neighborhood of the moon: k_e^2, the product of the Newtonian gravitational constant and the mass of the earth, and m_{m/m_e}, the ratio of the mass of the moon to that of the earth. If k_e^2 is determined from a trajectory of 100,000 km or more altitude, accuracy is better than 1 part in 10^6. Combined with measurements of the satellite period, an accuracy of 3 parts in 10^5 is attainable in a determination of m_{m/m_e}. A method of optical tracking using 10-ft metallized balloons is suggested.

Verification of impact is considered in some detail. The balloon method and the detonation of a nuclear bomb are suggested. The use of optical or infrared scanning to determine angular moon size as an indication of proximity offers one answer; and a less obvious method, measuring the moon's radioactivity by a spherically symmetric counter arrangement, offers another answer. These latter two methods depend on a data link with the vehicle. (JPL abstract)

1,108 VISUAL DETECTION OF LIGHT SOURCES ON OR NEAR THE MOON
Dole, S. H.
May 27, 1957
Rand Corp., Santa Monica, Calif.
RM-1900 (ASTIA AD-133,032)

Estimates are made of the minimum size of man-made light sources on or near the moon that would be visible by telescope to an observer on earth. On the basis of threshold illumination curves as a function of sky brightness, known properties of the eye, and calculated sky brightnesses in the neighborhood of the moon (aureole effects), a method is presented for calculating the minimum sizes of objects of various types which would be capable of producing detectable visual signals. A number of specific cases are given, including diffusely reflecting bodies (white powder spots or white-painted spheres), specularly reflecting objects (mirrors), fixed light emitters (searchlights), and single flashes (magnesium bombs) against backgrounds of various brightness levels. The most interesting case from a weight viewpoint is that of a low-altitude-type Air-Force illuminant detonated against a "dark" background such as the dark half of the half-illuminated moon. (Source abstract)

1,109 APPLICATION OF MICROLOCK TO IGY SATELLITE INSTRUMENTATION
Linnes, K., and Rechtin, E.
July 26, 1957
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
External Publication No. 404

The following characteristics of Microlock applicable to IGY instrumentation are considered: sensitivity, wide coverage, low power requirement, and simple telemetering system. The additions needed by a Minitrack station for receiving Microlock telemetered data are shown. The question of Microlock reception of Minitrack telemetering is also considered from an interest standpoint. The following graphs are presented: Microlock maximum detection range vs observation angle; beacon weight as a function of lifetime; ratio of telemetering range to detection range vs total bandwidth; and signal to noise ratio vs time from zenith crossing. (JPL abstract)

1,110 U.S. EXPLORER SATELLITES
Victor, W. K.
May 1, 1958
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
External Publication No. 491

A chronological history of the developments leading to Explorer I is presented. Objectives of Explorers I and III are listed, and agencies sharing in development of instrumentation for the experiments are mentioned. The Jupiter-C vehicle is described briefly; instrumentation for the Explorers is described more fully, and the calibration of components is explained. A brief report of telemetered information and the effectiveness of the communication system is also given. A short discussion of orbits is included. (JPL abstract)

1,111 VEHICLE MOTIONS AS INFERRED FROM RADIO-SIGNAL-STRENGTH RECORDS
Pilkington, W. C.
September 5, 1958
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
External Publication No. 551

The radio-signal-strength records from the Explorer satellites provided considerable information on staging, attitude, precession rate, spin rate, and ratio of moments of inertia. The records from the launching of each of the Explorers were investigated and gave information that could be used to determine the rate at which the cone angle of precession of the body increased and the time at which the body approached a tumbling motion. It is believed that radio-signal-strength records can be used in combination with other information to identify rocket vehicles, particularly after several similar vehicles have been received. The antenna patterns and transmitter frequencies of vehicles can be so designed that the removal of motional data from the records is much easier and more precise than it would be if this design factor had not been considered. (JPL abstract)

1,112 SPUTNIK MODULATION PATTERNS
Brown, W. E., Jr.
September 5, 1958
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
External Publication No. 552

A preliminary catalog and analysis are made of transmissions originating from Soviet satellites. The cataloging is principally concerned with the type of modulation pattern and geographical location of the emission. Locating the transmission source leads to estimated ephemerides, which in turn yield an estimated orbit injection point for the satellites.

The analysis of the modulation patterns includes a discussion of their information-carrying abilities for both the ideal situation and the actual case in which the pattern is affected by apparent propagation characteristics. Meaning of the patterns is treated in a speculative manner.

The satellite is a data-gathering and relaying device representing a new type of measurement philosophy. The problem of receiving the relayed data on a worldwide basis is outlined. (JPL abstract)

1,113 SATELLITE TRACKING FROM SEVERAL COORDINATED DOPPLER RECEIVING STATIONS
McDonald, W. S.
September 5, 1958
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
External Publication No. 554

A network of doppler satellite-tracking stations operated by independent organizations was established in the Southern California area for tracking Explorers I and III (1958 Alpha and 1958 Gamma). On the first pass, emphasis was placed on rapid data reduction and analysis to give immediate information on the orbital elements, perigee in particular. For launch conditions not too far from nominal, perigee was calculated within a few kilometers from first-pass data. Data analysis was carried out largely by graphical techniques. On later passes, an analog method was used to triangulate the satellites' positions. Additional stations were added to the network for tracking Explorer IV (1958 Epsilon). Orbit computation was done by a least-squares-fitting routine on a medium-speed digital computer. This routine was capable of using data from a single pass by several stations or from several passes by a single station. Microlock receivers equipped with electronic counters and digital printouts made available comparatively noise-free doppler-vs-time records during the actual satellite transit. (JPL abstract)

1,114 HUMAN HAZARDS OF SPACE FLIGHT
Stewart, H. J.
October 30, 1958
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
External Publication No. 564

The hazards of space flight discussed in this report are those concerned with the choice of reliable propellant systems. It is assumed that reliability of all phases of a manned space mission is of primary concern, especially to the crew. Two phases of propellant operation are considered. The first phase concerns the system used to launch the vehicle into space; the second phase concerns the fuel requirements of return to the earth. Amine and halogen fuels offer some promise for the launching phase. Solid propellants are considered unsatisfactory. Because of the storability problems (temperature and impact of space particles), the choice of a return trip fuel remains unsolved in this discussion. (JPL abstract)

1,115 **A SUMMARY OF THE PROPERTIES OF SPACE-CHARGE LIMITED BEAMS FOR THRUST APPLICATIONS**
Langmuir, D. B., and Shelton, H.
October 17, 1956
Ramo-Wooldridge Corp., Los Angeles, Calif.
Electronic Research Laboratory
ERL-102 (Revised)

The basic relationships among parameters and numerical values concerning the use of accelerated ion beams to achieve high specific impulses for propulsion are conveniently summarized. If any two of the variables (A, V, v, j, $\dot{m}$, W) are specified, the others are determined provided a value of d, the electrode spacing, is given. A chart is presented which provides a means for reading off the performance of any space-charge limited thrust system governed by the five equations. (JPL abstract)

1,116 **SENSORY REACTIONS RELATED TO WEIGHTLESSNESS AND THEIR IMPLICATIONS TO SPACE FLIGHT**
Schock, G. J. D.
April, 1958
Air Force Missile Development Center, Holloman AFB, N. M., Aeromedical Field Laboratory
AFMDC-TR-58-6; Proj. 7851

The implications of a sensory-starved environment have been reviewed and compared to conditions that will prevail in actual space flight. Recommendations for training for future space flight are presented. It is conjectured that in periods of weightlessness of several hours, the highly motivated space traveler would probably cope with sensory deprivation effects; but in longer periods, when rest would be a necessity, much heavier stress would be put on the individual. Ability to operate efficiently in spite of this stress can best be assured by psychiatric evaluation of the crewmen and long-term experiments in simulated space cabins. (JPL abstract)

1,117 **LUNAR PROBE FLIGHT: INTRODUCTION TO FLIGHT GEOMETRY AND ACCURACY PROBLEMS**
August 22, 1958
Army Department, Army Ballistic Missile Agency, Huntsville, Ala., Aeroballistics Laboratory
R-DA-TN-58-58

By studying the lunar probe flight by means of the two-body theory and referring to a target-referenced coordinate system, the quantitative discussion of the angular relationships encountered in probe flights are represented in an easily comprehensible manner. The basic parameter is the hour-angle, defined on the equator of the celestial sphere between the meridian of the injection point at time of injection and the meridian of the "translunar point" at time of encounter.

After the changing angular conditions are discussed in a descriptive manner, the angular relationships are presented quantitatively as functions of the hour-angle.

Further, it is shown quantitatively what injection coordinates are required to achieve given central angles, and probe flight times.

The problems of required accuracy and injection coordinates such as velocity, pitch and yaw angle, and launching time are discussed as well as the requirements for launch conditions to achieve continuous launch readiness.

The data are applied to a special numerical example of a probe flight of 34 hr transit time. (Source abstract)

1,118 **AN INTERIM MODEL ATMOSPHERE FITTED TO PRELIMINARY DENSITIES INFERRED FROM USSR SATELLITES**
Sterne, T. E., and Folkart, B. M.
December 31, 1957
Smithsonian Institution, Astrophysical Observatory, Cambridge, Mass.
Special Report 7

As earlier reported, preliminary values of the atmospheric density have been inferred from observations of artificial USSR earth satellites. Those densities were greater than the densities predicted by most atmospheric models at corresponding altitudes. This paper presents an interim and highly tentative atmospheric model adjusted to be the same as the ARDC model atmosphere, devised by Minzner and Ripley, at altitudes below about 90 km, and to agree with the densities inferred from the satellites at an altitude of 220 km. Although this model is crude and only roughly approximate, it may be of use in predicting the lifetimes of new earth satellites. (Source abstract)

1,119 **A PHOTOGRAPHIC SYSTEM FOR CLOSE-UP LUNAR EXPLORATION**
Davies, M. E.
May 23, 1958
Rand Corp., Santa Monica, Calif.
RM-2183; (ASTIA AD-156,021)

A description is given of a photographic system that may be used to obtain pictures of either the visible or hidden side of the moon from an early space vehicle. Existing components are suitable for the space vehicle. A panoramic-type camera can be designed in which the spin that stabilizes the vehicle also performs the scanning function for the camera. Tracking can be accomplished by radio. The recovery of the film after its return to earth appears feasible. (Source abstract)

1,120 **PROJECT RAND: MOTION OF A SMALL BODY IN EARTH-MOON SPACE**
Buchheim, R. W.
June 4, 1956
Rand Corp., Santa Monica, Calif.
RM-1726;(ASTIA AD-123,557)

This report presents basic analytical and numerical information relevant to the general problem of free motion in earth-moon space. A model of the earth-moon system is described, and a consistent set of numerical parameters is developed for this model. The major points of difference between the model and the true physical system are discussed, and numerical assessments of the importance of these differences are formulated.

Equations of motion of a small body in the field of the earth-moon model are presented, and a number of relevant coordinate systems are considered. The known integral to the equations of motion is introduced, and some fundamental deductions about the motion of a small body are drawn from this integral. These include the minimum requirements for earth-moon passage and for escape from the earth-moon system. Detailed properties of motion near certain special points, the "centers of libration," are described, and formulas and numerical data for orbit computations in these regions are given.

The related problem of motion in a nonrotating earth-moon system is also considered. (Source abstract)

1,121 **ASTRONAUTICS AND SPACE EXPLORATION: HEARINGS BEFORE THE SELECT COMMITTEE ON ASTRONAUTICS AND SPACE EXPLORATION (Printed for the use of the Select Committee on Astronautics and Space Exploration) 1958**
(Period covered: April 15–May 12, 1958)
Congress, 85th Congress, Second Session
House of Representatives
H. R. 11881

The purpose of the Select Committee on Astronautics and Space Exploration, as set forth by the House, was "to conduct a thorough and complete study and investigation with respect to all aspects and problems relating to the exploration of outer space and the control, development, and use of astronautical resources, personnel, equipment, and facilities." In short, the committee was confronted with the task of appraising President Eisenhower's proposal for a National Aeronautics and Space Agency and the various alternative proposals. The record of the first public hearing of the committee is presented here. (JPL abstract)

1,122 **PROJECT RAND: A CASEBOOK ON SOVIET ASTRONAUTICS (PART II)**
Krieger, F. J.
June 21, 1957
Rand Corp., Santa Monica, California
RM-1922 (ASTIA AD-133,018)

The first section of this report is a two-part bibliography of Russian books and periodicals dealing with various aspects of rocketry and astronautics. The second part consists of translations of the following books and periodicals: *Radioguided Rockets, Atomic Airplane of the Future, Atomic Engines, Television of the Future, Biological Problems of Interplanetary Flights, Experimental Verification of the General Theory of Relativity and Artificial Earth Satellites, Concerning the Competition for the K. E. Tsiolkovskii Gold Medal, Rendezvous with Mars, Before Flight into the Cosmos, Combustion, Applied Mechanics and Space Travel, Study of the Upper Atmosphere by means of Rockets at the USSR Academy of Sciences, Study of the Vital Activity of Animals During Rocket Flights into the Upper Atmosphere, Cosmic Boomerang, Some Question on the Dynamics of Flight to the Moon, The Problem of Creating an Artificial Earth Satellite,* and *USSR Rocket and Earth Satellite Program for the IGY.* (JPL abstract)

1,123 **OUTER SPACE PROPULSION BY NUCLEAR ENERGY: HEARINGS BEFORE SUBCOMMITTEES OF THE JOINT COMMITTEE ON ATOMIC ENERGY (Printed for the use of the Joint Committee on Atomic Energy)**
1958
(Period covered: January 22, 23; February 6, 1958)
Congress, 85th Congress, Second Session
Hearings

The complete testimony of the expert witnesses is included. This testimony gives good background information on the uses of nuclear power to carry large payloads great distances, as in interplanetary travel. Also included is background information on Project Rover and Project Pluto. (JPL abstract)

1,124 **PROJECT RAND: SCIENTIFIC SATELLITE-PAYLOAD CONSIDERATIONS**
Augenstein, B. W.
April 8, 1955
Rand Corp., Santa Monica, California
RM-1459

A preliminary examination has been made of items suitable for inclusion in the payload of a satellite designed for scientific research. Estimates have also been made of the possible weights and power requirements of these items. The performance of a number of payload combinations totaling 100 lb in weight has been investigated for various duty cycles. It is not the intent of this memorandum to present a complete payload design or specification; rather, it suggests what might be accomplished with a limited payload capacity. (Source abstract)

1,125 **THE ENGINEERING OF SATELLITE EXPERIMENTS**
Victor, W. K.
May 9, 1958
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
External Publication No. 501

This paper discusses some of the factors which influence the design of satellite apparatus and offers some suggestions for developing reliable flight hardware. Because of the complex nature of experimentation, a scientist may find it necessary to plan an entire program, including the control of the engineering design of the satellite experiment, and the responsibility for its operations in orbit. The following suggestions are offered for planning a satellite program: (1) have a sound objective; (2) secure approval and adequate funding; (3) find strong technical leadership; and (4) form a capable team, with clear-cut responsibility within the team, and promote the proper spirit of cooperation and mutual respect among the members of the team. (JPL abstract)

1,126 **UTILITY OF A CLOTH DISK ON A SMALL SATELLITE**
Lindquist, C. A., Henbree, R. V., and Currie, R. E.
April 18, 1957
Army Dept., Army Ballistic Missile Agency, Huntsville, Ala., Physics and Astrophysics Section
RPO-P-Technical Note 13

The difference in area of a cylindrical satellite when viewed from the side and from the end poses two major difficulties. First, if optical observation of the satellite by reflected light is required, the apparent brightness must surpass a minimum value. When the body presents its minimum area to the observer, it is a very dim object and therefore difficult to observe. Second, if the determination of the atmosphere density from orbital data is proposed, the variation of the area with attitude, and hence the drag, makes the determination problematical. To overcome the difficulties, a lightweight cloth disk can be incorporated in the satellite. This disk can be released after burnout of the final stage. When the cover is released from its container, the disk unfurls by centrifugal force, its plane being normal to the payload axis of rotation. (JPL abstract)

1,127 **EFFECT OF THE EARTH'S OBLATENESS AND ATMOSPHERE ON A SATELLITE ORBIT**
Fosdick, G., and Hewitt, M.
June, 1956
Martin Co., Baltimore, Md.
ER-8344

When the effects of the earth's oblateness and atmosphere are included in the orbital equations of motion for an earth satellite, the resultant differential equations are nonlinear. As such, they do not lend themselves to analytical treatment. These equations have been numerically solved on a high speed digital (IBM 701) computer. Results are presented herein for initial orbital altitudes as great as 300 statute mi, with inclination angles to the equator ranging from 90 to 0 deg. (JPL abstract)

1,128 **ROCKET FLIGHT AND EARTH SATELLITE ORBITS**
Norman, J. E.
July 1, 1958
Army Dept., Army Rocket and Guided Missile Agency, Huntsville, Ala., Ordnance Missile Laboratory
R-2R28P

The problem of rocket propulsion of an earth satellite into orbit is analyzed, utilizing Kepler's laws for description of orbital parameters. The motion of the rocket during powered flight is treated subject to certain simplifying assumptions, and final vehicle energy related to orbital energy. Examples of hypothetical satellite missions are given. (Source abstract)

1,129 **ON THE MID-COURSE NAVIGATION FOR MANNED INTERPLANETARY SPACEFLIGHT**
Unger, J. H. W.
August 28, 1958
Army Dept., Army Ballistic Missile Agency, Huntsville, Ala., Structures and Mechanics Laboratory
R-DSP-TR-2-58

An estimate shows that under certain conditions only a negligible amount of corrective fuel is required during interplanetary flight if the angular navigational error can be kept below some 10 microrad. It is confirmed that a celestial-optical navigation system with short-time inertial stabilization may, in principle, give the required accuracy if the optical instruments have an angular error of less than 5 microrad. A long-range radio system, yielding a lower accuracy, may be used as a backup. At present, a system of the stated accuracy would depend on human assistance in the space ship. It is recommended that work be continued on problems related to space navigation. (JPL abstract)

1,130 **SATELLITE RE-ENTRY DIVE WITH CONSTANT LIFT PROGRAM**
July 22, 1958
Army Dept., Army Ballistic Missile Agency, Huntsville, Ala., Aeroballistics Laboratory
R-DA-TN-41-58

The problem of descent of orbiters to the earth's surface has been discussed previously. This note continues the study by investigating flights resulting from applying a constant angle of attack for the whole length of flight. From the study it is obvious that the use of lift for a re-entry vehicle has a strong effect in reducing the deceleration peaks. This study was restricted to re-entry conditions that seem at present to be most practical, but it may be noted that higher supercircular velocities coupled with the proper path angle may also satisfy the deceleration restriction. With the assumption that re-entry conditions can be controlled within a reasonable degree of accuracy, the constant lift program (open-loop control) would be adequate in producing flights to meet the deceleration requirement. (JPL abstract)

1,131 **SOVIET ORBIT INFORMATION FOR USSR SATELLITES 1957 ALPHA TWO AND BETA ONE**
Schilling, G. F.
January 31, 1958
Smithsonian Institution, Astrophysical Observatory, Cambridge, Mass.

Revolutions and path distances, periods and heights, are reported for 1957 Alpha Two and Beta One. Final orbit decay reports for 1957 Alpha One and Two are given. Types of data reported from 1957 Alpha One and Two are listed. Soviet predictions of zones of visibility for 1957 Beta One are tabulated and graphed. (JPL abstract)

1,132 **FORMULAE, CONSTANTS, DEFINITIONS, NOTATIONS FOR GEOCENTRIC AND HELIOCENTRIC ORBITS**
Herrick, S.
May 28, 1957, 2nd ed.
Systems Laboratories Corp., Van Nuys, Calif., Spacenautics Division
R-SN1

This report is divided into five sections: (1) Two-body motions in the orbit plane are explained by equations of motion, and pertinent notations are given. (2) The usual orientation elements, the angles of node, inclination, and argument of perigee, are defined and the components of the unit vectors which are sometimes used instead of the angles are also explained. Other useful angles are mentioned and formulas are given for orientation. (3) The relating of a geocentric or heliocentric position of a satellite to a position located from a definite place is explained. Geocentric equatorial systems are expressed when the reference is to the vernal equinox, to Greenwich, and to local meridian; a geocentric horizon system is expressed when referred to local meridian. (4) The problem of dynamical reference for geocentric systems is attacked. The relationships between the fixed equatorial system and the rotating equatorial system are explained. Other dynamical systems based on a fixed initial horizon, a horizon rotating with the earth, a horizon rotating with the satellite, and an equator rotating with the satellite are also explained. The spherical components (radial, transverse, and orthogonal) as referred to the equator, and the same classes of spherical components plus tangential and normal as referred to the orbit, are pointed out. (5) The units and gravitational constants are defined for two types of geocentric measurement and for heliocentric measurement. The gravitational constant is expressed in an equation for geocentric measurement based on the g-radius unit of distance. The corresponding constant for geocentric measurement based on the megameter is denoted. The unit of time may be the second or the "unit of τ." Any mass unit may be adopted, since the central mass is absorbed into the gravitational constant. Transitions to heliocentric orbits are mentioned. A detailed table of geocentric and heliocentric constants or conversion factors is presented, and the uses of the constants are detailed. (JPL abstract)

1,133 OPTICAL SATELLITE TRACKING PROGRAM: MISCELLANEOUS INFORMATION ON THE ARTIFICIAL EARTH SATELLITES
Hynek, J. A., Schilling, G. F., *et al*
April 30, 1958
Smithsonian Institution, Astrophysical Observatory, Cambridge, Mass.
Special Report 12

The following papers pertaining to the USSR satellites are included: *Soviet Orbit Information for Satellite 1957 Beta, Moonwatch Observations of the Fall of Satellite 1957 Beta One, A Precision Measurement of the Brightness of Satellite 1957 Alpha One,* and *Note on the Mass-Area Ratios of the USSR Satellites.* The following papers pertaining to the US satellites are included: *Moonwatch Catalogue, The Acceleration of Satellites 1958 Alpha and Gamma, The Secular Perturbations and the Orbital Acceleration of Satellite 1958 Beta Two,* and *Improvements in the Prediction Program for Crossings of Given Latitude Parallels.* The following papers were also given: *Densities of the Upper Atmosphere Derived from Satellite Observations,* and *Technical Parameters of the Artificial Satellites.* (JPL abstract)

1,134 **ORBIT DETERMINATION OF RECOVERY SATELLITE**
Speer, F.
October 7, 1958
Army Dept., Army Ballistic Missile Agency, Huntsville, Ala.
R-DA-TN-71-58

In another report, R. F. Hoelker investigated the feasibility and accuracy limitations of a general recovery satellite scheme. Considering the scatter of (a) injection conditions, (b) retrieve kick, and (c) atmospheric re-entry, Hoelker concluded a rms range deviation of ± 140 km and a cross-range deviation of ± 110 km of the recovery impact. It is the purpose of this report to show how these figures compare with the accuracy attainable with the ABMA orbit determination scheme. It is concluded that with the present orbit evaluation scheme the retrieve point of a recovery satellite will not be known better than by 60 km in position, 10 mc in velocity amount, and 0.5 deg in velocity angle. This leads to a higher impact scatter than quoted by Hoelker. The exact amount of the resulting impact dispersion depends on the particular type of recall operation finally selected. (Source abstract)

1,135 **LUNAR SURFACE FEATURES AND INTERNAL DEVELOPMENT OF THE MOON**
Kuiper, G. P. (Yerkes Observatory, Williams Bay, Wis.)
April 29, 1958
Data Publications, Washington, D.C.
2 ASTRO-13

A general discussion is given of the surface features of the moon. There are three main types of surface texture on the moon: (1) maria and "flattened" craters, which reflect about 5% or less of the light and which are nearly flat, suggesting that they are composed of lava fields, (2) a chain of mountain ranges surrounding Mare Inbrium and clearly composed of vast masses of ejected matter derived from Mare Inbrium itself, and similar, smaller systems surrounding maria prominent in the moon such as the craters Aristotle and Alphoneus; certain ejected areas about the original lunar surface have been obliterated by innumerable irresolute movements and continuous masses of rock which by their patterns appear to have been distributed while in a viscous condition, and (3) what appears to be an "original" lunar crust, nearly spherical in shape, in which have been sculptured a large number of craters, large and small, often overlapping, which by their own characteristics have a distinct time sequence. Superimposed on the surface types just described are several classes of small features. They are (1) craters and grooves, (2) ray systems, (3) mountains and hills, (4) ridges, (5) rills, (6) faults, and (7) extinct volcanoes. A general description is given of these. (JPL abstract)

1,136 **DUST ON THE MOON**
Gold, T. (Harvard University, Cambridge, Mass, Harvard College Observatory)
April 29, 1958
Data Publications, Washington, D.C.
2 ASTRO-11

This report presents several arguments in favor of the theory that a dust layer covers the moon. The conclusion reached is that at a depth of a few hundred feet the moon would almost certainly be quite solid. The top few feet may well be extremely loose and more treacherous thân quicksand. (JPL abstract)

1,137 **FEASIBILITY STUDY FOR MINIMUM-WEIGHT RADIO INSTRUMENTATION OF A SATELLITE**
Sampson, W. F.
June 15, 1956
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
Publication No. 48;(ASTIA AD-104, 246)

The study reported was undertaken to determine the feasibility of including in a minimum-weight satellite sufficient radio instrumentation to allow detection of the vehicle and determination of its position. Data requirements have been examined, and expected environmental conditions have been evaluated. The necessary radiated power and desirable operating frequencies have been determined. Possible configurations for an airborne beacon and an appropriate ground station and antenna have been studied. The objective has been to obtain maximum performance with minimum weight while paying adequate attention to environmental problems. The present study examines, in particular, the instrumentation problems of a satellite vehicle. Instrumentation for a high-velocity re-entry vehicle can be performed in a similar manner, but higher radiated power may be required, depending upon the trajectory chosen. (Source abstract)

1,138 **SIMPLIFIED SATELLITE PREDICTION FROM MODIFIED ORBITAL ELEMENTS**
Cormier, L. N., Goodwin, N. *et al*
August 29, 1958
National Academy of Sciences, National Research Council, Washington, D.C.

The problem of supplying predication data for IGY satellite observers is discussed in terms of the need for providing a large number of stations with "fresh" data in a useful form. A straightforward method is given whereby an observer can (1) eliminate all but potentially significant observation periods; (2) for any such period determine the precise time when the satellite will cross (or approach) his latitude circle, the longitude of the crossing (or approach), and the satellite height; and (3) derive from such crossing (or approach) data the azimuth, elevation, and slant range to the satellite for one or more optical observations, or comparable data for radio observations. The message forms, computation forms, tables, and charts that may be used for graphic solutions are given. (Source abstract)

1,139 A SHORT PROGRAM FOR THE DETERMINATION OF SATELLITE ORBITS
Harris, I., and Jastrow, R.
Presented in Moscow: Summer 1958
Navy Dept., Naval Research Laboratory, Washington, D.C.

The program described here is designed for the rapid production of an approximate satellite ephemeris from a small number of radio tracking observations. The input data consist of (1) a subsatellite fix, i.e., latitude and longitude at a given time, (2) initial approximations to the orbital inclination, planar orbit elements, and drag coefficient, and (3) three or more radio observations. The observations may be in any of the forms normally obtained from tracking stations, such as bearing, elevation, slant range, and latitude or longitude crossing times for the station. A program prepared for the IBM 704 computer first integrates the equations of motion with atmospheric drag included, using initial approximations to the orbit elements, and computes the position of the satellite relative to each of the observing stations. The program then corrects the orbit elements and drag coefficient to give agreement with the original observation. (Source abstract)

1,140 THE BEGINNINGS OF RESEARCH IN SPACE BIOLOGY AT THE AIR FORCE MISSILE DEVELOPMENT CENTER, HOLLOMAN AIR FORCE BASE
Hanrahan, J. S., and Bushnell, D.
January, 1958
Air Force Missile Development Center, Holloman AFB, N. M., Office of Information Services

This study is limited to an examination of the early beginnings (1946-1952) of space biology research at what has since become the Air Force Missile Development Center. This is the period when the first such biological experiments of this program were attempted, and when even rudimentary techniques for placing these experiments into the proper environment by means of balloons and rockets had to be devised. A bibliography of pertinent documents is included. (JPL abstract)

1,141 **THEORETICAL ANALYSIS OF DOPPLER RADIO SIGNALS FROM EARTH SATELLITES**
Guier, W. H., and Weiffenbach, G. C.
April, 1958
Johns Hopkins University, Silver Spring, Md.,
Applied Physics Laboratory, Bumblebee Section T
Bumblebee R-276; NOrd-7386

A method of determining the orbit of an artificial satellite from measurement of the doppler shift of its radio signals is described. Neglecting atmospheric effects, each possible ballistic orbit produces a unique time dependence of the doppler shift. Consequently, the accuracy with which orbital elements can be determined depends only on (1) the accuracy with which refractive effects can be described, (2) the accuracy of the measurements, and (3) having the satellite pass close enough to the receiving station so that a sufficient portion of the doppler shift is received. The six orbit elements and the transmitter frequency and one additional parameter arising from a parameterization of the index of refraction are contained in the theoretical expression for the doppler shift. The least-squares criterion is used to fit the theoretical doppler formula to a particular set of experimental doppler measurements by adjusting these parameters. The results obtained by applying this procedure to data for one pass of Sputnik I and three passes of Explorer I are presented. It was found that quite respectable accuracy in the values of the orbital elements can be obtained from a single pass of the satellite near one receiving station. This suggests that a doppler tracking system in which data from successive passes at two or more receiving stations (widely separated) are combined simultaneously in a single least-squares fit should provide a very competent method of tracking satellites. (Source abstract)

1,142 **SATELLITE MICROMETEORITE MEASUREMENTS**
Manring, E., and Dubin, M.
May 12, 1958
Air Force Cambridge Research Center, Mass.,
Geophysics Research Directorate
Satellite Report

Numerous meteorite and micrometeorite detectors were devised for satellite testing. The gauges developed present a total of about 2 sq in. of sensitive area and each is sensitive to the impact of a single micrometeorite of 5 to 10 microns in diameter. The individual gauges are 1 cm^2 in area and are wound with 17-micron-diameter enameled wire in two layers. An impact upon one of the gauges destroys its electrical continuity, and this is reported back by telemetery. The microphone detector detects the acoustical energy generated by particles which impact the skin and charges the frequency of a subcarrier generator. With about 10% of the microphone data and perhaps 50% of the gauge data from Explorer I available, it is possible to provide the following information: (1) seven hits have been detected by the microphone, and (2) after 32 days not more than one gauge has registered an impact. (JPL abstract)

1,143 **MAJOR ACHIEVEMENTS IN SPACE BIOLOGY AT THE AIR FORCE MISSILE DEVELOPMENT CENTER, HOLLOMAN AIR FORCE BASE**
Bushnel, D., and Hanrahan, J. S.
March, 1958
Air Force Missile Development Center, Holloman AFB, N.M., Office of Information Services

This study records the scientific, technological, and administrative advances made at Holloman Air Force Base during 1953–1957 in the field of space biology. Important technological advances, discussed in the initial portion of this study, contributed to outstanding accomplishment in two broad fields of space biology: cosmic radiation and controlled artificial environments. Scientific and engineering progress in these latter fields is the main theme of this publication. A bibliography of pertinent documents is included. (JPL abstract)

1,144 **OFFICIAL CSAGI VERSION OF TWO USSR SATELLITE REPORTS**
June 19, 1958
National Academy of Sciences, National Research Council, Washington, D.C.
Memorandum TP-23

Results of scientific researches on the Soviet satellites are presented. Radio and optical observations of the artificial earth satellites are discussed together with air-density measurements made, results of the ionospheric investigations, studies of cosmic rays, and results of the biological investigation using the test dog, Laika. The launching of the third Soviet satellite and the equipment it carries is discussed. (JPL abstract)

1,145 **PROJECT RAND: LUNAR INSTRUMENT CARRIER ATTITUDE STABILIZATION**
Buchheim, R. W.
June 4, 1956
Rand Corp., Santa Monica, Calif.
RM-1730; (ASTIA AD-112,402)

The various attitude disturbances acting on a moon rocket are considered and their magnitudes are estimated. It is shown that the attitude-stabilization requirements can be satisfied by spinning the vehicle at about 80 rpm around its roll axis. Effects of vehicle shape and mass distribution on the attitude problem are examined, and design restrictions are indicated. (Source abstract)

1,146 SCIENTIFIC USE OF AN ARTIFICIAL SATELLITE
Kallmann, H. K., Rapp. R. R., *et al*
September 6, 1955
Rand Corp., Santa Monica, Calif.
P-733

A brief summary is given of the general areas of study which can be opened with the advent of the first artificial satellite. The areas include: (1) solar radiation in the ultraviolet and X-ray region, (2) electron density measurements, (3) pressure, density, and composition measurements, (4) cosmic rays, (5) the albedo of the earth, (6) observations of meteors, (7) measurement of the earth's magnetic field, (8) artificial seeding of the atmosphere, (9) geodetic measurements, and (10) cosmic and solar high-frequency radio noise. (JPL abstract)

1,147 THE EQUATIONS OF MOTION OF A TUMBLING RE-ENTRY BODY
Dobies, E. F.
November 22, 1957
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
Progress Report No. 20-339

A set of equations is presented which may be used to describe the re-entry trajectory of a coasting tumbling rocket. The equations of motion are kept as general as possible, except that the azimuth coordinate is linearized and Coriolis and Magnus forces are neglected. (Source abstract)

1,148 THE TEMPERATURE OF AN ORBITING MISSILE
Hibbs, A. R.
March 28, 1956
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
Progress Report No. 20-294

The successful operation of radio equipment carried in an orbiting missile requires fairly close control over the temperatures to which the equipment is subjected. This temperature is controlled by two factors. First, the temperature of the outer shell of the missile depends on radioactive transfer between the missile and its environment (sun, earth, and empty space). Second, the temperature of the equipment inside the missile depends on heat transfer from the shell (directly by radiation and through the structure by conduction). The analysis presented shows (1) how the average temperature of the outer shell can be controlled (for a given missile shape, orientation, and trajectory) by a correct choice of surface coatings, and (2) that the limits of temperature variation of the enclosed equipment can be held to within a few degrees of this average shell temperature by adequate insulation. Numerical calculations are presented which indicate the necessary characteristics of the coating and insulating materials. (Source abstract)

1,149 MICROLOCK: A MINIMUM WEIGHT RADIO INSTRUMENTATION SYSTEM FOR A SATELLITE
Sampson, W. F., Richter, H. L., Jr., and Stevens, R.
November 14, 1956
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
Progress Report No. 20-308

The design, construction, and laboratory testing of a satellite-tracking system are described. The tracking mechanism employs a low-power light-weight flight transmitter in conjunction with a receiving system of advanced design. The flight transmitter will radiate 3 milliwatts for 3 months and will provide two narrow-band telemetering channels in a unit having a total weight of 1½ lb. The ground receiving equipment is capable of acquiring and tracking the beacon signal at a line-of-sight distance of 3000 mi and at any azimuth and elevation angle. Interferometer antennas could be used to determine the angular position of the satellite with an accuracy of 1 mil, which is equivalent to approximately ± 0.04 sec in the determination of the period. (Source abstract)

1,150 PROPOSAL FOR MODIFICATION OF THE STATE UNIVERSITY OF IOWA COSMIC RAY EXPERIMENT FOR THE JUPITER C VEHICLE
December 2, 1957
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
Publication No. 115

The proposed experiments for the launching of two earth satellites by the Jupiter C re-entry test vehicle are outlined. The first experiment has the objective of gathering environmental data, flight-testing major items of hardware, and making certain scientific measurements. The second experiment, a modified State University of Iowa cosmic ray experiment, has the objective of ascertaining primary cosmic-ray intensity; description and block diagrams are given for the instrumentation. (JPL abstract)

1,151 LUNAR DUST FOCUSING EFFECTS AND A POSSIBLE TECHNIQUE FOR RECOVERING SAMPLES FROM THE SURFACE OF THE MOON
Stewart, R. M.
December 30, 1957
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
Publication No. 116

A discussion is presented of the possibility of causing large portions of dust blown off the moon's surface to converge on the earth in high concentration at a fairly predictable location and time. The apparent rarity of the moon's atmosphere should make it possible for such small particles to escape. Particles ejected in different directions (roughly, toward the earth) with just enough excess energy to escape from the "potential well" around the moon over into the "potential well" around the earth will tend to fall toward the center of the earth in a converging cone. (JPL abstract)

1,152 **CALIBRATION RECORD FOR THE IGY EARTH SATELLITE 1958 ALPHA**
Randolph, L. W., and Choate, R. L.
February 5, 1958
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
Publication No. 130

This is the first of two reports which describe the calibration of the instrumentation for the IGY earth satellite 1958 Alpha. This report gives the calibration curves required for reducing the data from the satellite. (Source abstract)

1,153 **ENGINEERING NOTES 9-J-MICROLOCK STATION**
December 1, 1957
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
(Engineering Notes)

These instructions contain information on the operation of the Microlock station and a description of its major units and their interrelationship. It is intended for personnel who are familiar with the operation of the Microlock station and who have been trained in electronics maintenance with experience in performance testing, operation, alignment, and adjustment of similar types of equipment. (Source abstract)

1,154 **EQUATIONS OF MOTION OF A MISSILE AND A SATELLITE FOR AN OBLATE-SPHEROIDAL ROTATING EARTH**
Kalensher, B. E.
April 12, 1957
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
Memorandum No. 20-142

The equations of motion of a rocket are derived by applying the fundamental definition of the derivative to Newton's second law of motion. Three independent cases are considered: motion of the missile about a transverse axis through the center of mass and rotation of the missile about the longitudinal axis. The second case describes the motion in pitch (or yaw), and the third case describes the rotation (spin or roll) of the missile due to a ring of small jets placed around its circumference. The equations of motion of the center of mass are then modified to describe the motion of a satellite moving around the earth in a nearly circular orbit. Finally, a method is developed for computing the approximate impact point of the missile by algebraic means. (Source abstract)

1,155 SATELLITE ORBITAL PERTURBATIONS CAUSED BY THE EARTH'S OBLATENESS
Lass, H.
October 20, 1958
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
Section Report No. 1-43

The averaging process for nonlinear equations introduced by Kryloff and Bagoliubioff is briefed, and the system of coordinates based on the Euler angles is explained. The Eulerian coordinates are used in setting up the equations of motion. The averaging process is used first with two differentials to show that the plane of the motion remains inclined at a constant angle with the equatorial plane of the earth and to show the rate of regression of orbital motion. Equations are set up for radical motion and then for orbital motion (in which the average eccentricity of orbit remains constant and the line of perigee rotates at a determined rate). (JPL abstract)

1,156 ABSORPTANCES TO SOLAR AND TERRESTRIAL RADIATION OF SURFACES CONSIDERED FOR USE ON THE EXPLORER SATELLITES
Shipley, W. S.
September 15, 1958
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
Section Report No. 12-161

The purpose of this report is to record the values of the absorptances to solar and terrestrial radiation of ten sample surfaces considered for use on the Explorer satellites. The problem of determining the temperature of a satellite is briefly reviewed, pointing out the need for the values of these radiation constants. The procedure for evaluating these constants and the results of the evaluation are discussed. Of the ten surfaces, four are 410 stainless steel, untreated, fine sandblasted, and sandblasted and heated in air to 600°F; four are 430 stainless steel, etched, fine sandblasted and heated lightly abraded with 600 mesh alumina on billiard cloth by hand; and two were untreated stainless Rokide A on 410 stainless steel. One of the Rokide coats showed the least absorption of solar radiation; the abraded 430 stainless exhibited lowest absorption of terrestrial radiation and that from a black body at 300°K. (JPL abstract)

1,157 **CALIBRATION RECORDS FOR THE IGY EARTH SATELLITE 1958 GAMMA**
Choate, R. L.
June 27, 1958
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
Publication No. 126

The purpose of this report is to present the necessary calibration records for reducing and interpreting the data from the IGY earth satellite 1958 Gamma. A brief description of each instrumentation system is given and the calibration procedures are outlined. The calibration curves for each measured quantity is given, and calculated error curves are included for use in evaluating the data. (Source abstract)

1,158 **THE TRANSFORMATION OF EARTH-REFERENCED DATA TO INERTIAL COORDINATE SYSTEMS**
Albright, N. W.
June 24, 1958
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
Section Report No. 12-155

This report is directly concerned with the missile accelerometers and associated missile platform of a missile guidance system. The platform is a mechanism with respect to which the missile can determine its orientation. This platform determines a coordinate system. If the missile accelerometers are attached to the platform, the measured acceleration will be resolved in this coordinate system. Two types of platforms are considered here: the nonprecessed platform, which retains its orientation in inertial space, and the precessed platform, the orientation of which is at all times the same as a coordinate system fixed at the missile launcher. A brief introduction to geodesy is given prior to discussion of the problem. The transformation from earth-fixed coordinates to missile coordinates is then explained for both precessed and nonprecessed platforms. The accuracy required in the equations of transformation and gravity, the accuracy of latitude determination and deviation of the vertical, and the dependence of the transformation equations and of gravity on the various parameters are discussed. The final section, concerning the equation of gravity, includes the effects to be considered, the gravitational potential, the formula for sea-level value of effective gravity, and the equation of gravity expressed on the spherical vector basis with spherical variables and on the Cartesian vector basis with both spherical and Cartesian variables. (JPL abstract)

1,159 **PROJECT RAND: LUNAR INSTRUMENT CARRIER-LANDING FACTORS**
Lang, H. A.
June 4, 1956
Rand Corp., Santa Monica, California
RM-1725; (ASTIA AD-112,403)

This report considers the problems of landing the instrument package portion of a rocket on the moon's surface in good operating condition. This will require that the instrument package come to rest in an upright position so that its aerial can function properly. The factors governing successful landing are the nature and crushing strength of the moon's surface and the weight, velocity, shape, strength, and angle of impact of the instrument package. Landing situations for a vehicle decelerated by a braking rocket prior to impact are emphasized. A penetration spike of exceptionally strong alloy on the forward point of the instrument package can be used to increase the prospects for a successful landing. Unconventional landing possibilities are considered briefly. (Source abstract)

1,160 **AIR FORCE SURVEYS IN GEOPHYSICS: THE ARDC MODEL ATMOSPHERE 1956**
Minzner, R. A., and Ripley, W. S.
December, 1956
Air Force Dept., Air Research Development Command, Cambridge Research Center, Mass., Geophysical Research Directorate, Survey-86
AFCRC-TN-56-204; (ASTIA AD-110,233)

A realistic model of atmospheric properties based on reliable observations and current theories is presented. Fifteen atmospheric properties are discussed and tabulated, thirteen to 500 km and two to only 90 km. The values of these properties are internally consistent through classical equations and are dependent upon (1) a defined, linear-segmented, molecular-scale temperature function, (2) a molecular-weight function, and (3) an acceleration of gravity function. Values of twelve physical constants required in the computations are adopted as exact. Internationally agreed upon, exact transformation factors are employed in converting from metric to English units. Both metric and English tables are presented and computational procedure is discussed. A thorough discussion of geopotential altitude, effective radius of the earth, and molecular-scale temperature is given. The relative virtues and validities of two methods for computing the acceleration of gravity are discussed. The concept and validity of the various properties as applied to high altitudes are considered. (Source abstract)

1,161 PROJECT RAND: SCIENTIFIC USE OF AN ARTIFICIAL SATELLITE
Kallmann, H. K., and Kellogg, W. W.
June 8, 1955
Rand Corp., Santa Monica, California
RM-1500

The importance of a man-made satellite has been studied. In the first of three major parts of this report scientific topics are discussed for which valuable information can be obtained only from an artificial satellite. These topics include: (1) solar radiation in the ultraviolet and X-ray region, (2) electron density measurements, (3) pressure, density, and composition measurements, (4) cosmic ray measurements, (5) albedo of the earth, (6) observations of meteors, (7) measurements of the variation of the earth's magnetic field, (8) artificial seeding of the atmosphere, (9) atmospheric drag measurements, (10) geodetic measurements, and (11) cosmic and solar high-frequency-radio noise.

The uses of this information in solving scientific problems are described. Auxiliary requirements of attitude control, sensing devices, and telemetering equipment are investigated. Conclusions are presented in a table showing the type of observations to be made from an artificial satellite and the various orientation requirements on the vehicle. (JPL abstract)

1,162 ATTITUDE CONTROL OF EARTH SATELLITES
Noton, A. R. M.
June 3, 1958
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
External Publication No. 505

The most promising scheme for establishing reference directions would seem to be one which employs two horizon seekers for two directions and a single-degree-of-freedom gyro which aligns itself normal to the orbital plane. Such a scheme can have a relatively rapid response (necessary to gain lock) compared to the other two possibilities considered. Optical horizon seekers with gyroscopic memories for the nights are envisaged. Satellite rotation by means of on-off reaction jets is preferable to the use of flywheels, and when the form of the transient response is not of prime importance it has been shown possible to design an on-off jet-reaction system for attitude control which does not hunt in the steady state. The characteristics of the horizon seeker and inevitable delays in the rocket system have been included in this study, yet no nonlinear feedback was necessary. The general conclusion is, therefore, that such an on-off control is practicable and does not imply a persistent waste of rocket fuel. Only a few ounces of monopropellant would be required, and the whole system of compressed air bottle, valves, and jets (for control in roll, pitch, and yaw) should weigh only a few pounds. (Source abstract)

1,163 **COAXIAL TURNSTILE ANTENNA FEED SYSTEM**
Potter, P. D., Davis, E. F., and Schuster, D.
September 3, 1958
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
Invention Report No. 20-94

The antenna feed system described in this report was used on Explorer I. The coaxial turnstile device divides the total rf power equally among four antennas with a progressive phase delay of 90 deg between the antennas. If the characteristic impedance of the coaxial cable is denoted by Z_0, the device will provide an output impedance of approximately Z_0 for resistive antenna impedances in the range of $0.5Z_0$ to $2Z_0$. The unusual feature is that the output impedance is almost independent of the antenna impedances, provided the latter are equal. (JPL abstract)

1,164 **EXIT AND RE-ENTRY PROBLEMS**
Bull, G. V., and Enkenhus, K. R.
October 21-22, 1957
Institute of the Aeronautical Sciences, Great Britain
Preprint 759

Some of the problems associated with the exit and re-entry portions of long-range ballistic rocket trajectories are reviewed. The nature of typical ballistic trajectories is considered in order to establish the range of values of pertinent parameters, followed by various phases of some of the flight problems associated with the range of parameters indicated. The aerodynamic control, drag, and heating effects are considered for the free-molecular region. High Mach flow problems in the slip-flow regions are complicated by high-temperature real gas effects and the existence of nonequilibrium flow about the body. Low-density tunnel facilities can be used to check many effects at lower M. For the continuous-flow region, high temperatures, thermodynamic nonequilibrium air flow, control problems, pressure coefficients, drag, and heat transfer are considered. The laboratory simulation of extreme hypersonic flight conditions is a problem of gathering data on certain simulations and estimating corrections for the effect not simulated. Intermittent helium wind tunnels (Bogdonoff, Princeton) and shock tunnel facilities (Hertzberg and Henshal), simulation of temperature by jets and solar furnaces, simulation of Knudsen number in low-density wind tunnels (suitable still for $M \leq 5$), and the hyperballistics ranges represent answers to some of the problems of testing. A list of 21 references is given. (JPL abstract)

1,165 **SPIRALING FROM A CIRCULAR ORBIT WITH SMALL THRUST**
Shelton, H.
November 8, 1956
Ramo-Wooldridge Corp., Los Angeles, Calif., Electronic Research Laboratory
ERL-LM-102

The calculation assumes an essentially circular satellite orbit whose radius is slowly increasing. A differential equation is set up by considering the rate at which energy is put into the orbital motion. The velocity increment in free space is compared with that in the presence of a gravitational field. Slow acceleration and impulsive acceleration are considered for escape from the earth's field. A useful case, that in which some additional velocity is required after leaving the earth's field, is taken up and results are presented in a table. (JPL abstract)

1,166 **CATALOG OF RADIO SIGNALS FROM SPUTNIK I (JPL COLLECTION)**
Basore, B. L., and Brown, W. E., Jr.
January 29, 1958
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
Publication No. 120

This catalog of recorded radio signals from Sputnik I (Artificial Earth Satellite 1957 Alpha Two) has been compiled with the intention of evaluating the recorded data as to its suitability for further study. The catalog attempts to list not only the definitive factors such as place and time of intercept, but also observed anomalies in the record that might be indicative of intelligence impressed on the transmitted signals. An over-all statement of judgment that these anomalies were, in fact, transmitted and not a contribution of the receiving equipment and/or operators is occasionally included.

An outline or index of the individual records is presented in order of orbit number, followed by a discussion of each record. A summary of the orbit information which was used to fix the satellite position in each case is included. (JPL abstract)

1,167 **EVALUATION OF THE ABSORPTIVITIES OF SURFACE MATERIALS TO SOLAR AND TERRESTRIAL RADIATION, WITH PLOTS OF THE REFLECTANCES (AT WAVELENGTHS OF 0.4 TO 25μ) FOR TEN SAMPLE MATERIALS INCLUDING TWO TYPES OF FIBROUS GLASS-REINFORCED PLASTIC**
Shipley, W. S.
April 11, 1957
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
Progress Report No. 20-319

A graphic evaluation was made of the absorptivities of 6 samples of stainless steel, both coated and uncoated, to solar and terrestrial radiation. The reflectance measurements required for this evaluation were performed by the Mechanical Engineering Department of the University of California at Berkeley. The reflectances for 10 sample materials suitable for use on an orbiting vehicle were measured at selected wavelength intervals between 0.4 and 25μ. Six of the samples investigated were 410 stainless steel, treated as follows: (1) sandblasted and unheated, (2) sandblasted and heated to 600°F, (3) smooth and heated to 1300°F, (4) sandblasted and heated to 1300°F, (5) Rokide-coated and heated to 1300°F, and (6) Rokide-coated, polished, and heated to 1300°F. Two of the 10 samples were of 91 LD fibrous-glass-reinforced plastic (FRP); one sample was unheated, and the other was heated to 750°F. The remaining 2 samples were of silicone G7 FRP, one unheated and the other heated to 750°F. Although the absorptivities were evaluated for only the stainless steel samples, the reflectance data for the remaining materials are presented in graphic form. (JPL abstract)

1,168 **THE EXPLORER ROCKET RESEARCH PROGRAM**
Robillard, G.
October 31, 1958
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
Publication No. 145

The nine Jupiter-C missiles launched at Cape Canaveral between September 1956 and October 31, 1958 are accounted for: the propulsion system, air frame, and guidance components were tested in the first; a re-entry nose cone was tested in the second and third; the remaining six were used as launching vehicles for Explorers I through IV. The design of the four-stage Jupiter-C is explained in detail, including modifications made for certain firings. The firing sequence is also explained fully, including the production and acceleration of rotational speed. The failures of Explorers II, V, and VI are discussed. The payloads and orbits of Explorers I, III, IV are detailed and the scientific data accumulated mentioned. (JPL abstract)

1,169 THE DIFFERENCE BETWEEN SATELLITE AND BALLISTIC MISSILE RE-ENTRY PROBLEMS
Riddel, F. R., and Teare, J. D. (Avco Manufacturing Corp., Stratford, Conn., Avco Research Laboratory)
April 29, 1958
Data Publications, Washington, D.C.
2 ASTRO-9

A quantitative comparison of satellite and ballistic missile re-entries is made with respect to heating rates, total heat input and decelerations encountered. For the nonlifting vehicle a linear analysis of the ballistic-missile re-entry has been made by Allen and Eggers. This simplified procedure is not generally applicable to satellite re-entry. The satellite in general experiences much lower decelerations, and both deceleration and heating occur over a longer time (by an order of magnitude) than for a ballistic missile. The heating occurs at higher altitudes for the satellite, giving lower heating rates but higher total heat inputs. Heat absorption methods are less applicable to satellites, while radiating surfaces seem more feasible. The equations governing re-entry of a satellite are detailed in an appendix. For orbits with slight ellipticity the decay process is nonlinear. Only in the circular re-entry case, previously discussed by Sanger, where the tangent of the angle of the velocity vector is equal to the product of the density, the reciprocal of the ballistic drag parameter, and $g_0 r$, is a linearized treatment usable. A brief discussion of the re-entry of lifting vehicles is included. (JPL abstract)

1,170 EVOLUTION AND NATURE OF THE LUNAR ATMOSPHERE
Vestine, E. H.
January 29, 1958
Rand Corp., Santa Monica, California
RM-2106

The theory is advanced that the lunar atmosphere is highly tenuous and that its density is less than that of the F_2 region of the earth's atmosphere. Argon is the most probable constituent, but it is possible that xenon, krypton, carbon dioxide, sulfur dioxide, and some water vapor are also present. Solar wave radiation and corpuscular radiation will affect surface and atmospheric temperatures, as will the internal distribution of temperatures, The atmosphere will also be affected by the escape rates of gases, and these may be estimated for a wide range of temperatures by assuming an isothermal atmosphere. (Source abstract)

1,171 A PREAMPLIFIER DESIGN FOR SATELLITE RECEIVERS
Patterson, K. H.
July, 1958
Army Dept., Aberdeen Proving Ground, Md., Ballistic Research Laboratory
MR-1154

Preamplifiers for use at 108 mc have been designed and constructed by BRL. An exceptionally low noise figure has been achieved even though all tubes employed are of conventional, single-ended, plug-in construction. The optimization technique, which is primarily responsible for the performance, is developed on a theoretical basis followed by details for the practical application. (Source abstract)

1,172 HEAT TRANSFER TO SATELLITE VEHICLES RE-ENTERING THE ATMOSPHERE
Kemp, N. H., and Riddell, F. R.
October, 1956
Avco Manufacturing Corp., Stratford, Conn., Avco Research Laboratory
Research R-2; AF 04(645)-18

A theoretical approach to the aerodynamic problems associated with re-entry which has been developed at AVCO is reported; it may be used for velocities up to the satellite velocity and at altitudes up to the extreme limit of the continuum flow regime. Combining this with the limiting values of heat transfer that occur in the free molecule flow at very high altitudes allows a fairly accurate calculation of the heat transfer to a satellite entering the atmosphere. (JPL abstract)

1,173 EXPERIMENTAL RESULTS OF THE U.S. ROCKET PROGRAM FOR THE INTERNATIONAL GEOPHYSICAL YEAR TO JULY 1, 1958
Hanessian, J. Jr., and Guttmacher, I.
July 30, 1958
National Academy of Sciences, National Research Council, IGY World Data Center A, Rockets and Satellites, Washington, D.C.
IGY Rocket Report Series No. 1

This is the first group of papers describing results obtained in connection with the US IGY program in rocketry. The following papers are included: *The First Year of the U.S.-IGY Rocket Program*; *Atmospheric Structure Above Ft. Churchill*; *Density in the Winter Nighttime Arctic Upper Atmosphere, 110 to 170 km*; *Rocket Measurements of the Arctic Upper Atmosphere*; *Arctic Atmospheric Structure at 250 km*; *Seasonal and Latitude Variations in Upper-Air Density*; *Temperatures and Winds in the Arctic as Obtained by the Grenade Experiment*; *Pressure, Temperature and Density at 90 km over Ft. Churchill*; *The Measurement of Diffusive Separation in the Upper Atmosphere*; *Diffusive Separation in the Winter Nighttime Arctic Upper Atmosphere, 112 to 150 km*; *Ion Composition of the Arctic*

Ionosphere; Results Obtained with Rocket-Borne Ion Spectrometers; Atmospheric Composition at Arctic High Altitudes; Rocket Arctic Ionospheric Measurements; Ionosphere Electron Densities and Differential Absorption; Rocket Measurement of Soft Radiation; Direct Measurement of Radiation Associated with Visible Aurorae; Rocket Auroral Investigations; X-Ray and Ultraviolet Emission of Solar Flares; X-Ray Emission of Solar Flares; Far Ultraviolet Radiation in the Night Sky; Intensity of Solar Lyman α and Adjacent Ultraviolet Emission Lines; Rocket Astronomy in the Far Ultraviolet; A High Resolution Ultraviolet Spectrogram of the Sun; Gamma Ray Intensities at High Altitudes; Molecular Oxygen Densities in the Mesosphere over Ft. Churchill; A Latitude Survey of Cosmic Radiation; Evidence for Ionospheric Currents Near the Geomagnetic Equator; U.S. Air Force Rocket Program for IGY; and *IGY Upper Air Research at the Ballistic Research Laboratories.* (JPL abstract)

1,174 **THE VANGUARD SATELLITE COMMAND RECEIVER**
Helper, D. S.
September 30, 1958
Navy Dept., Naval Research Laboratory, Washington, D.C.
Proj. Vanguard-R-35

The earth-satellite command receiver has been developed at the request of Project Vanguard. This receiver turns on the satellite instrumentation upon command from a ground-based Minitrack station. The receiver is a VHF double-superheterodyne type utilizing a small portion of the 108-mc Minitrack transmitter power as the first local oscillator. The basic design of the various components provides for economical use of satellite battery power and at the same time a reasonable degree of security against accidental interrogation from unauthorized sources. (Source abstract)

1,175 **HUMAN TOLERANCE TO SOME OF THE ACCELERATIONS ANTICIPATED IN SPACE FLIGHT**
Bondurant, Stuart, *et al*
April, 1958
Wright Air Development Center, Wright-Patterson AFB, Ohio, Aero Medical Laboratory
WADC-TR-58-156; Proj. 7216; (ASTIA AD-151,172)

Selected studies of human tolerance to the linear accelerations which are anticipated in space flight have been reviewed. As defined in these studies, tolerance limit is determined by the loss of a critical faculty, i.e., ability to see, think, or exercise at least finger control. Tolerance times at g level between 2 and 12 in various body positions are presented. The capacity of subjects to stand repeated peaks of acceleration similar to those encountered in multistage rocket vehicles has been explored. Tolerance times longer than any previously reported are obtained by immersion of the subject in water in the semisupine position. (Source abstract)

ASTRONAUTICS INFORMATION ABSTRACTS, PART B

January 1–April 30, 1959

1,176 VISUAL OBSERVATIONS OF ARTIFICIAL SATELLITES
Zamorski, A. D.
Priroda, 1958
Hope, E. R., translation
January, 1959
Directorate of Scientific Information Service, Defence Research Board, Canada
T313R

Interesting meteorological information can be obtained from naked-eye observations of artificial earth satellites. A study of satellite color variation from almost white to red during the last part of the visible track aids in defining the quantitative characteristics of the effect the earth's atmosphere has on the rays of the sun. An extinguishment of the satellite often means the presence of clouds which extend high above the earth and are usually related to cyclones. Tumbling and other astronomical characteristics of the satellite complicate the evaluation of data obtained.

1,177 PHOTON RESEARCH CONDUCTED BY MEANS OF THE THIRD ARTIFICIAL EARTH-SATELLITE
Chudakov, A. Ye.
Priroda, 1958
Hope, E. R., translation
February, 1959
Directorate of Scientific Information Service, Defence Research Board, Canada
T316R

Sputnik III was equipped with a luminescence counter to record the upper atmospheric photons. The counter consisted of an amplifier and a cylindrical crystal of sodium iodide plus a photomultiplier. The data were telemetered and the transmitter operated continuously during the orbiting of the satellite. The code and the reception method used are described.

Analysis of data is not complete, but initial results show that the counter efficiently records roentgen radiation and exceeded the expected cosmic ray rate. It was established that there is only an insignificant increase of ionization in the high-count region. Preliminary results indicate that the study of retardation emission is a method which may yield important information on the intensity of the corpuscular flux and its nature.

1,178 APPLICATIONS OF A NEW TECHNIQUE FOR RECORDING SKIN RESISTANCE
Levy, E. Z., Thaler, V. H., and Ruff, G. E.
(Wright Air Development Center,
Wright-Patterson AFB, Ohio, Aero Medical Laboratory)
November 17–21, 1958
American Rocket Society, New York 36, N. Y.
Report 679-58

Operational conditions requiring a person to be attentive and competent over a prolonged period of time have stimulated extensive research on fatigue and its detection. In manned space flight it will be particularly desirable to monitor crews for fatigue and alertness by some simple and reliable physiological or bioelectrical device. This paper is a summary of recent efforts at the Aero Medical Laboratory to apply the measurement of skin resistance to research on these problems. The conclusion reached was that if a differentiation between alertness and awakeness can be made, with corrections for environmental influences, then continuous measurement of the absolute level of skin resistance may be a suitable bioelectrical means of remotely monitoring space crew members.

1,179 MODIFIABILITY OF DAY–NIGHT CYCLING
Hauty, G. T. (School of Aviation Medicine,
Randolph AFB, Texas)
November 17–21, 1958
American Rocket Society, New York 36, N. Y.
Paper 680-58

At the present time, day–night work cycling has assumed considerable practical importance, and a real need exists for pertinent information in that area. This paper presents the results of studies to determine high and low proficiency points of "space crews" during performance of tasks on special work schedules. Both individuals and groups were studied and tested. The normal daily schedule consists of three 8-hour periods, work, sleep and recreation. The revised schedule used in these tests was made up of six 4-hour periods of alternating work and recreation.

1,180 THE GEODETIC SATELLITE
Haviland, R. P. (General Electric Co., Philadelphia, Pa.)
November 17–21, 1958
American Rocket Society, New York 36, N. Y.
Paper 711-58

This paper considers the construction, operation, and recovery of satellites that would be useful geodetic information gatherers. No definite design plans are given, but many problems which are involved in constructing and operating such satellites are described and solutions are suggested.

1,181 OBSERVATIONS OF THE RUSSIAN SATELLITES ON 20 MC
Paetzold, H. K.
November 24, 1958
Max Planck Institute, Munich, Germany,
Institut für Stratopharenphysik
Sm/2274

During the flights of Sputniks I, II, and III, observations were made with a newly developed direction finder which uses three pairs of adcock antennas. The direction of the wavefront and the amplitude of the received signal can be measured on a television tube. The effects of the ionosphere on the orbits of the satellites are discussed, and it is concluded that the radio observation of satellites at 20 mc is of some advantage. The influence of the ionosphere at this frequency facilitates study of many problems of wave propagation.

1,182 SOME STRUCTURAL ASPECTS OF ORBITAL FLIGHT
Gerard, G. (New York University)
November 17–21, 1958
American Rocket Society, New York 36, N. Y.
Paper 729-58

This paper contains a review of certain structures and materials problem areas associated with the various phases of orbital flight. Approaches to the solution of some tension and compression structures problems are presented and various research areas of importance in orbital flight are delineated.

1,183 STRUCTURES FOR SPACECRAFT
Sandorff, P. E. (Massachusetts Institute of Technology, Cambridge)
November 17–21, 1958
American Rocket Society, New York 36, N. Y.
Paper 733-58

Some problems of structural design to be encountered in vehicles specifically intended for interplanetary operations are reviewed. Consideration is given to the relative merits of different types of shell structure, dynamic surging effects possible in thin-wall tankage, and the problem of meteor protection. Some effects of structural considerations on the system design are indicated.

1,184 **STRUCTURAL CONSIDERATIONS OF MANNED SPACE VEHICLES**
Coppa, A. P. (General Electric Company, Philadelphia, Pa.)
November 17–21, 1958
American Rocket Society, New York 36, N. Y.
Paper 732-58

This paper considers the structural requirements for a manned space vehicle. It gives approaches leading to an optimum vehicle, considering human factors and the requirements of thermodynamics in addition to structures. The necessity of early and thorough integration of these different requirements is emphasized. Several space-vehicle configurations are presented, including a ballistic and a glide type, in order to exemplify some of the various structural problems encountered in each type during space flight, entry into an atmosphere, and landing. These problems include aerodynamic heating and loading, meteoroid impact, and other problems. Materials and constructions suitable for optimum space structures are discussed sufficiently to demonstrate available choices and indicate areas of required development.

1,185 **BRAZED SANDWICH STRUCTURES FOR MISSILES AND SPACE VEHICLES**
Cremer, G. D., and Mueller, R. S. (Solar Aircraft Co., San Diego, Calif.)
November 17–21, 1958
American Rocket Society, New York 36, N. Y.
Paper 730-58

This paper discusses present capabilities in the field of braze joining. Emphasis is directed toward high-temperature corrosion-resistant brazing applications. A descriptive presentation of selected sandwich-type structures serves as the means to accomplish this purpose. Many examples are given. Important applications are discussed where corrosion resistant brazed assemblies are found on current missiles.

1,186 SUMMARY OF ELECTRONIC SATELLITE TRACKING OPERATIONS FOR SOVIET SATELLITES 1957 ALPHA-2 AND 1957 BETA, HIGH ALTITUDE INSTRUMENTATION REPORT NO. 1

Prenatt, R. E., Bentley, B. T., and de Bey, L. G.
October, 1958
Army Dept., Aberdeen Proving Ground, Md.,
Ballistic Research Laboratories
Memo Report No. 1174

Radio transmission from the two Soviet satellites (1957 Alpha Two and 1957 Beta) was monitored by the Ballistic Research Laboratories. A brief description of the instrumentation system is presented. Radio doppler and interferometer data were taken for 1957 Alpha Two, and doppler data were taken for 1957 Beta. Slant ranges, pass times, and (for 1957 Beta) transmitter frequencies were determined from the data. Variations in signal strength that frequently occurred are described, and possible explanations of their cause are mentioned. Methods of reducing the data are discussed. A procedure for determining the times during which the satellite is visible is developed, and two methods of determining satellite position from two monitoring stations are derived.

1,187 OPTICAL OBSERVATIONS OF ARTIFICIAL EARTH SATELLITES

Gindin, Ye. Z., and Leykin, G. A.
October 8, 1958
U. S. Joint Publications Research Service, Washington, D. C.
JPRS (NY) Report No. 723

USSR optical observation of artificial earth satellites is conducted at 66 visual observation stations and 24 photographic observation stations. The method of visual observations consists of the determination of the satellite's position in the sky at a certain fixed moment; this determination is carried out by observations of the satellite's passing with the telescope AT-1 or a theodolite. The time moment is registered by means of a tape recorder or a printing chronograph and is checked by radio. The photography is accomplished with the camera NAFA-3c/25 (diameter of objective, 10 cm; focal length, 25 cm), and the operation of the shutter is registered with a printing chronograph. Optical observations are also carried out with large telescopes. The possibility of using light flares on the satellite for precise determination of its coordinates is discussed. An appendix gives a list of observation stations together with data concerning optical observation of artificial satellites.

1,188 **WHAT HAVE WE LEARNED FROM VANGUARD?**
Rosen, M. W. (National Aeronautics and Space Administration)
November 17–21, 1958
American Rocket Society, New York 36, N. Y.
Paper 719-58

Reasons for the lack of success of Project Vanguard are not readily apparent. The component failures that marred individual flights were tracked down. These, however, were only the surface aspects of deep-seated problems that arose early in the program and have not been solved. Owing to the concentration on performance and schedule, reliability and simplicity became secondary considerations. The use of production methods for vehicle fabrication made it difficult to incorporate design changes. The extensive preflight testing for which Vanguard is noted may have led to a less than optimum result. Finally, the project was conducted in a climate of excessive publicity. These problems are not unique to Vanguard and are being encountered in most developmental missile and space flight projects.

1,189 **SOME TECHNICAL PAPERS PRESENTED AT THE ROCKET AND SATELLITE SYMPOSIUM**
(Fifth Reunion of the Comité Special Année Géophysique Internationale held in Moscow, July 30–August 9, 1958)
November 26, 1958
National Academy of Sciences, National Research Council, Washington, D. C.

A complete list of the papers presented at the symposium is given. Thirty-one of the papers are presented in full in this report. The papers are entitled: *On the Density of the Upper Atmosphere Derived from Observations of Satellites 1957 Alpha and Beta and Supplement; An Interim Atmosphere Derived from Rocket and Satellite Data; Decay of Spin in Sputnik I; Simplified Satellite Prediction from Modified Orbital Elements; A Short Program for the Determination of Satellite Orbits; Progress of the British Upper Atmospheric Rocket Research Programme; Power Sources for Satellite and Space Vehicles and Supplement; A Radioactive-Ionization-Gage Pressure-Measurement System; Preliminary Report on the Instrumentation and Operation of the Explorer Satellites; Demise of Satellites 1957 Alpha I and 1957 Beta; General Aspects of Satellite Observation in Japan; Photographic Satellite Tracking with 35-mm Cameras; A Comparison of Orbital Theory with Observations Made in the United Kingdom on the Russian Satellites; Australian Rocket-Satellite Programme for the I.G.Y.; Progress Report on the Japanese I.G.Y. Rocket Program; Surveying by Astrometry of Rocket-Flashes; Stellar Magnitude of Vanguard Satellites and of the Vanguard Third Stage Rocket Casing; The Analysis of Doppler Records from Earth Satellites; A Radio-Interferometer Giving Continuous Information of Bearing; United Kingdom Tracking of Russian Satellites by Reception of Their 20 and 40 Mc/s Transmissions; Radar Observation of the Second Russian Earth Satellite; Some Simultaneous Radio Direction-Finding and Doppler Frequency Shift Measurements on the Russian Artificial Earth Satellites and the Study of Radio Wave Propagation;*

Amateur Radio Measurements of Soviet Satellites; The Use of Interferometer Observations of Satellites for Measurement of Irregular Ionospheric Refraction; Electron Densities in the Ionosphere from Radio Doppler Tracking of Artificial Earth Satellites; Cosmic Rays Observed by Satellite 1958 Alpha; Radiation Observations with Satellite 1958 Epsilon; Micrometeorite Impact Measurements on a 20-in.-Diameter Sphere at 700 to 2500 Kilometers Altitude.

1,190 UNMANNED PHOTOGRAPHIC EXPEDITION TO THE MOON
Collins, J. J., Johnson, R. W., and Stephens, J. E.
May, 1958
Massachusetts Institute of Technology, Cambridge, Instrumentation Laboratory
Report T-162

The factors involved in an unmanned photographic reconnaissance of the normally unseen side of the moon have been examined in order to set forth a possible equipment design and trajectory.

General equations of vehicle motion in earth-moon-sun space are developed, and then specialized to a two-coordinate system, with the justification for this simplification stated. Machine computation was carried out with these equations to define sixteen free-fall trajectories, each passing through a different altitude in an arbitrary launch zone and attaining an arbitrary altitude, both behind the moon and at closest approach to the earth on return from the moon. Equipment is designed for orientation of the vehicle in transit and for photographing the unseen side of the moon. Close approach to the earth on return permits telemetry of the photographic data (electronically reduced) or, when technology permits, recovery of the vehicle itself.

The appendixes contain, in detail, the derivation of the equations of motion for describing the path of an infinitesimal vehicle in the earth-moon-sun space, the IBM 650 Flat Program, the mechanization of the trajectory equations for the IBM 650, ancillary derivations, and the two possibilities presented for orientational control and stabilization.

1,191 PRELIMINARY RESULTS OF SCIENTIFIC INVESTIGATIONS CARRIED OUT WITH THE AID OF THE FIRST SOVIET ARTIFICIAL EARTH SATELLITES AND ROCKETS
Galkin, A. M., Gorlov, O. G., Petrov, A. V., and Serov, A. D.
U. S. Joint Publications Research Service, Washington, D. C.
JPRS/DE-288

Two reports are presented, one dealing with investigations of the vital activities of animals during flights in hermetically sealed cabins to an altitude of 212 km, and the other with investigations of the vital activities of animals during flights in a nonhermetically sealed rocket cabin to an altitude of 110 km. During flight, the pulse, blood pressure, and respiration of the dogs chosen as the experimental animals were recorded and electrocardiograms were taken. The data obtained from these records were used to estimate the extent of the effects of high g stress and of re-entry. Descriptions are given of the apparatus used in recording the data and of the equipment in the cabin.

1,192 **DETERMINATION OF THE FLATTENING OF THE EARTH BY MEANS OF THE DISPLACEMENT OF THE NODE OF THE SECOND SOVIET SATELLITE**
(Paper presented at the Rocket and Satellite Symposium during the Fifth Reunion of the Comité Special Année Géophysique Internationale held in Moscow, July 30–August 9, 1958)
Buchar, E.
National Academy of Sciences, National Research Council, Washington, D. C.

The oblateness of the earth is determined mathematically from an analysis of the nodal position of the second Soviet satellite. Because of imperfect observational data, the results of the work lack precision.

1,193 **AGARD AVIONICS PANEL—SATELLITE WAKES**
Tulin, M. P.
January 6, 1959
Office of Naval Research, London, England
Technical Report ONRL-C-2-59

The Eighth General Assembly and Technical Panel Meetings of the Advisory Group for Aeronautical Research and Development (AGARD) were held in Copenhagen, October 20–29, 1958. The Avionics Panel concerned itself with the subject of the long-range detection of high, fast-moving bodies. Approximately 100 delegates and observers from thirteen NATO nations heard about twenty presentations concerned with radar observations of earth satellites, their radio emissions, and ionospheric effects such as the generation of plasma motion by satellites. The presentations of experimental and theoretical evidence of the existence of strongly ionized satellites wakes are reviewed. Besides the fact that ionized wakes are of obvious practical significance in that they may provide significantly large radar targets for bodies traveling at high speeds in the ionosphere, the electrohydrodynamic phenomena which may be responsible for their existence would seem of considerable interest in themselves.

Collected abstracts of papers on the program of the Avionics Panel, including many not concerned with ionized wakes, are presented in an appendix.

1,194 CURRENT STUDIES AT WALTER REED
Yessler, P. B. (Walter Reed Army Institute of Research, Washington, D. C.)
November 17–21, 1958
American Rocket Society, New York 36, N. Y.
Paper 682-58

The problems of stress and behavior in humans and animals are studied. A stress experiment centered around 25 control subjects and 25 subjects deprived of sleep for 98 hours is the main subject. Many physiological and psychological tests of the subjects were made before, during, and after the experiment. One major difference between this sleep-loss experiment and previous such experiments was the fact that the subjects did not become more and more irritable as sleep loss progressed. The reason given for this phenomenon is that the subjects of this experiment were treated rather tenderly.

Animals were also tested for reactions to shock-type stress situations. Findings of the tests are given in graph form.

1,195 PHOTOELECTROMETRIC STUDY OF THE NIGHT SKY LUMINESCENCE
Bolshakova, L. G., Georgiyevski, Yu. N., Otto, A. N., and Rodionov, S. F.
Moscow, 1958
Hope, E. R., translation
January, 1959
Directorate of Scientific Information Service, Defence Research Board, Canada
T315R

IGY operations made it necessary to obtain detailed data on the time variation of the night sky luminescence, particularly as to its diurnal variation. The circuit design of the converted equipment is shown. It was necessary to automatize the existing photoelectrometer installation, thus enabling a continuous recording and making possible the observation of a marked increase in the night sky emission, which lasted about 5 minutes. It was found that the diurnal variation curves registered at a 3,900-mile altitude were much smoother than the curves at a 2,200-mile altitude.

1,196 PHASE-METHOD STUDY OF LARGE-SCALE INHOMOGENEITIES IN THE IONOSPHERE
Mirkotan, S. F., and Drachev, L. A.
Moscow, 1958
Hope, E. R., translation
January, 1959
Directorate of Scientific Information Service, Defence Research Board, Canada
T314R

At Moscow National University a phase method is being used to research the fine structure of the ionosphere. This method consists of recording, at three mutually separated points on the earth's surface, the variations of the phase path of the reflected field from the ionosphere. An important feature of the phase method is an increased precision in recording the phase-path variation, making possible a statistical approach in calculating drift velocities.

1,197 BIOTHERMAL ASPECTS OF RE-ENTRY FROM EXTRA-ATMOSPHERIC FLIGHT
Carter, E. T., and Bell, M. W. J. (North American Aviation, Inc., Los Angeles, Calif.)
November 17–21, 1958
American Rocket Society, New York 36, N. Y.
Paper 704-58

This paper points out certain biothermal problems that are expected to arise as a result of atmospheric re-entry of a manned vehicle. Some solutions are presented, although the authors admit that they fall far short of being acceptable answers to the problem. It is also pointed out that these methods take into account only the stress of temperature and do not consider the possibility that other stresses such as hypoxia or high *g* loading are present at the same time. These additional stresses could cause an intolerable situation for the vehicle occupant. More information is needed regarding human performance under the combined stresses of heat and acceleration.

1,198 SEALED CABINS: AREA OF INDECISION
Cooper, I. (Rand Corp., Santa Monica, Calif.)
November 17–21, 1958
American Rocket Society, New York 36, N. Y.
Paper 698-58

Some of the problems involved in sealed-space-cabin operations are discussed and analyzed. Included are aspects of human functions, physiological instrumentation requirements, cabin size and decompression events, radiation shielding, and cabin structure as related to respiration requirements.

1,199 **THE ELECTROENCEPHALOGRAM AS A STATE OF CONSCIOUS INDICATION UNDER BALLOON FLIGHT CONDITIONS**
(College of Medicine, Baylor University)
November 17–21, 1958
American Rocket Society, New York 36, N. Y.
Paper 685-58

The physical and electronic problems involved in taking electroencephalogram readings of subjects during balloon flights are briefly discussed. Previous experiments preparatory to these studies are described.

1,200 **NAVY INTERESTS IN SEALED CABINS**
Ross, M. D. (Office of Naval Research, Washington, D. C.)
November 17–21, 1958
American Rocket Society, New York 36, N. Y.
Paper 694-58

The problems of human confinement in a sealed cabin are dealt with briefly. The Navy is understandably concerned with such a situation as related to submarines, but here the problems of high-altitude flight are also considered. Carbon dioxide removal, oxygen regeneration, clothing, psychological reactions to prolonged confinement, and some other subjects are mentioned in connection with previous experiments. It is obvious from the results of the psychological and physiological tests that the sealed cabin must always be designed around the occupant, and in no case should the occupant be expected to adapt himself to prolonged situations of stress and discomfort.

1,201 **PSYCHOPHYSIOLOGICAL ASPECTS OF A MULTIPLE CREW COMPARTMENT STUDY**
Gell, C. F. (Office of Naval Research, Washington, D. C.)
November 17–21, 1958
American Rocket Society, New York 36, N. Y.
Paper 681-58

This paper describes an experiment to determine the highest concentration of oxygen that can be delivered to a group of humans without the possibility of oxygen poisoning. Six men were kept in a sealed chamber for seven days. The chamber was maintained at 10,000 ft to reduce nitrogen content to 103 mm Hg pressure, and oxygen pressure was provided at 418 mm Hg. The subjects performed well during the entire experiment. They were in satisfactory physiological condition after the test, although two showed some signs of slight oxygen toxemia.

1,202 ACCELERATIONS OF SPACE FLIGHT
Stapp, J. P. (Wright-Patterson AFB, Ohio)
November 17–21, 1958
American Rocket Society, New York 36, N. Y.
Paper 700-58

Extensive explanations and test results are given for experiments that were made to study the reactions of the human body to accelerations. Conditions similar to those encountered during entry into orbit, escape, and re-entry are thoroughly evaluated. The conclusion is reached that the well-oriented human can withstand the discomfort caused by these *g* forces.

1,203 CLIMATIC AND STRUCTURAL ASPECTS OF SEALED CABINS
Dickey, F. L., and Knipp, G. H. (Douglas Aircraft Co., Tulsa, Okla.)
November 17–21, 1958
American Rocket Society, New York 36, N. Y.
Paper 699-58

This paper considers the advantages to the crew of an optimum internal atmosphere and pressure together with the effects on a sealed cabin structure. The reliability of the cabin and its resistance to fast fracture are discussed and, with proper cabin design, are shown to be essentially constant for various internal pressures. Certain safety advantages of a cabin designed for high pressure are pointed out, e.g., a greater resistance to meteoroid penetration and a longer decompression time should a penetration occur. Means of increasing the time and decompression to permit effective emergency action are discussed, and the need for complete reliability of the sealed cabin system is emphasized.

1,204 A UNIFIED ANALYTICAL DESCRIPTION OF SATELLITE ATTITUDE MOTIONS
Roberson, R. E. (Autonetics Division of North American Aviation, Inc., Downey, Calif.)
November 17–21, 1958
American Rocket Society, New York 36, N. Y.
Paper 722-58

Previous formulations of the equations of satellite attitude motion together with the perturbation torques on the satellites are unified and generalized. Equations of motion are developed in terms of arbitrarily large attitude-deviation angles relative to an arbitrary attitude reference frame. Explicit expressions are obtained for effective external and parametric excitation torques from internal moving parts, inertial reaction control parts, and the motion of the attitude reference frame. The gravitational torque on the satellite is given in the sense of a definite sequence of manipulations, although the final result is not explicit. The equations of motion are linearized, and an expression is derived for the excitation torque which arises from the second-order terms usually neglected.

1,205 ELECTRIC ARC GAS HEATERS FOR RE-ENTRY SIMULATION AND SPACE PROPULSION
Brogan, T. R. (AVCO Research Laboratory, Everett, Mass.)
November 17–21, 1958
American Rocket Society, New York 36, N. Y.
Paper 724-58

Because the available test time is limited, questions involving the exposure of materials to the high-energy re-entry environment cannot be answered in contemporary quasi-steady sources of high-temperature air. This paper describes the development and calibration of an arc-powered wind tunnel designed to provide steady flow simulation of the conditions encountered during re-entry. Flight velocities between 16,800 and 21,800 ft/sec can be simulated with this device. The flow properties in the tunnel test section can be determined to a degree of accuracy sufficient for quantitative experiment.

The arc has been proposed as the gas heater for an electrically propelled space vehicle. The concluding section of the paper contains some remarks on this application of the arc. The results of a preliminary study of helium as an arc-heated propellant are presented.

1,206 SELECTED REPORTS PRESENTED BY THE USSR AT THE FIFTH MEETING OF THE SPECIAL COMMITTEE FOR THE INTERNATIONAL GEOPHYSICAL YEAR (CSAGI)
November 18, 1958
U. S. Joint Publications Research Service, Washington, D. C.
JPRS/DC-287

A variety of reports on satellites, satellite observations, and atmospheric investigations is presented. Titles and authors of the reports included are: *Dynamic Effects in the Motion of Artificial Satellites,* L. I. Sedov; *Solar Batteries,* V. S. Vavilov and A. P. Landsman; *Results of Optical Observations of the Soviet Earth Satellites,* A. G. Masevich; *Biological Experiments on Rockets and the Artificial Earth Satellites,* V. I. Yazdovsky; USSR *Amateur Radio Observations of Signals from the Soviet Artificial Satellites,* A. M. Shakhovskoy; *Determination of Satellite Orbit Elements by Means of the Doppler Effect; Preliminary Report on Geomagnetic Measurements on the Third Soviet Artificial Satellite,* S. Sh. Dolginov and N. V. Pushkov; *Investigations of the Ion Composition of the Earth's Atmosphere by Rockets and Satellites,* V. G. Istomin; *Absorption of Radiowaves in the Ionosphere and F_2 Layer Structure According to Data of Field Intensity Measurement of Radio Signals of Artificial Earth Satellites,* A. N. Kazantsev; *Heavy Nuclei in Primary Cosmic Radiation,* L. V. Kurnosova, L. A. Razorenov, and M. I. Fradkin; *Rocket and Satellite Investigation of Meteors,* I. N. Nazarova; *Certain Results of Measurements of Thermodynamic Parameters of the Stratosphere with the Aid of Meteorological Rockets,* Prof. Ye. G. Shvidkovsky; *Preliminary Results of Determination of Atmospheric Density Above 100 Kilometers,* V. V. Mikhnevich; and *Disturbances of Gas Environment Caused by Satellite Flight,* B. A. Mirtov.

1,207 A PRELIMINARY EXPERIMENT WITH RECOVERABLE BIOLOGICAL PAYLOADS IN BALLISTIC ROCKETS: PROJECT MIA
van der Wall, F. L., and Young, W. D.
(Space Technology Laboratory, Los Angeles, Calif.)
November 17–21, 1958
American Rocket Society, New York 36, N. Y.
Paper 715-58

This report includes a detailed description of the physical system, the preliminary tests and flight preparations, the instrumentation used in flight, and the resulting signal pattern of Project MIA (Mouse-in-Able). The special problems associated with the use of living payloads in space-flight vehicles are also discussed.

1,208 SPACE LAW: RECENT PRACTICAL ACHIEVEMENTS (Two Parts)
Haley, A. G., and Yeager, P. B.
PLANNING FOR THE SPACE AGE: THE NATIONAL AERONAUTICS AND SPACE ACT OF 1958
Eastman, S. E. (Massachusetts Institute of Technology, Cambridge)
November 17–21, 1958
American Rocket Society, New York 36, N. Y.
Paper 714-58

The first paper deals with the Russians' use of radio frequencies of 20.005 and 40.002 mc without the permission of the International Telecommunication Union. The second paper relates to the compiling of available information on space law. The third paper points up the necessity for more concern over laws governing the use of outer space.

1,209 SPACE CABIN REQUIREMENTS AS SEEN BY SUBJECTS IN THE SPACE CABIN SIMULATOR
Hawkins, W. R., and Hauty, G. T. (Randolph AFB, Texas)
November 17–21, 1958
American Rocket Society, New York 36, N. Y.
Paper 702-58

Information on such subjects as nutrition, noise, communication with the outside world, clothing, work–sleep schedules, and temperature and humidity effects are discussed in relation to space-cabin requirements. The cabin used in the experiments is described. The reactions of various subjects to the conditions imposed on them during flight are presented together with suggestions for future improvements.

1,210 THE EXPLORER ROCKET RESEARCH PROGRAM
Robillard, G. (California Institute of Technology, Pasadena,
Jet Propulsion Laboratory)
November 17–21, 1958
American Rocket Society, New York 36, N. Y.
Paper 718-58

The Explorer program is covered briefly but thoroughly. Included is information on the design of the Jupiter-C launching vehicle, the firing sequence of each stage, and the payloads and orbits of Explorers I, III, and IV and the data they gathered.

1,211 FAR SIDE ROCKET RESEARCH PROGRAM
Karsch, H. L. (Allison Division, Central Motors Corp.,
Indianapolis, Ind.)
November 17–21, 1958
American Rocket Society, New York 36, N. Y.
Paper 717-58

A description of the Far Side program is given, including vehicle design experiment instrumentation, the data-link system, and the conduct of tests. Cosmic ray and magnetic field experiments were performed. The program was considered successful.

1,212 THE SECULAR AND PERIODIC PERTURBATIONS OF THE ORBIT OF AN ARTIFICIAL EARTH SATELLITE
Krause, H. G. L.
Nelson, S., translation
September 17–22, 1956
Army Ballistic Missile Agency, Redstone Arsenal, Huntsville, Ala.

The motion of an earth satellite in an orbit inclined to the earth's equator is investigated. Secular perturbations of this orbit caused by the oblateness of the earth and by the sun and moon and periodic perturbations caused by the atmosphere of the earth are analyzed. For a selected orbit of the earth satellite, it is shown numerically which secular and periodic perturbations are the most important. Furthermore, for a nonstationary orbit, where the atmospheric resistance has still relatively great influence, an analytic formula is developed for the computation of the lifetime of the satellite. Numerical values for this lifetime are in fairly good agreement with other estimates.

1,213 **MINITRACK DATA FOR THE ARTIFICIAL EARTH SATELLITES 1958 ALPHA AND 1958 BETA FROM 7 MAY 1958 TO 20 MAY 1958**
Hocking, W. M.
September 22, 1958
U. S. Naval Research Laboratory, Washington, D. C.
NRL Report 5198

The information necessary to permit satellite orbit computations from raw Minitrack data is given, and the Minitrack data on the satellites 1958 Alpha and 1958 Beta for the period May 7–20, 1958 are presented in appendixes. The use of the data is intended to encourage and facilitate the development of new computation techniques.

The basic Minitrack measurement and the data message are described, and a discussion is made of the handling and preparation of the data message for the Vanguard IBM 704 computer. The outputs of the computer are also briefly discussed. Residual data from the 704 computer's differential correction program and meridian crossing times and elevation angles from the Burroughs E101 computer are given for each message.

Two correction formulas are given for adjusting the raw data. One of these corrects for over-all station factors only and may be used alone if an error of about 1% is tolerable; the other corrects for the 1% error introduced by antenna pattern distortion and system crosstalk. Station constants and other information required or useful in these calculations are included in the appendixes.

1,214 **AN APPLICATION OF DYNAMIC PROGRAMMING TO THE DETERMINATION OF OPTIMAL SATELLITE TRAJECTORIES**
Bellman, R., and Dreyfus, S.
August 19, 1958
Rand Corp., Santa Monica, Calif.
P-1463

A simplified satellite trajectory problem corresponding to a flat-earth assumption first treated by Okhotsimskii and Eneer is considered. A numerical solution based upon the functional equation technique of dynamic programming and a proof of the fundamental result in the analytical solution are presented.

Although in this simplified study the rocket is flown at maximum thrust until burnout and the thrust direction obeys a simple law, the computational scheme assumes neither of these results. It is therefore applicable to more general problems that are not amenable to conventional mathematical analyses.

1,215 **ATMOSPHERIC PHYSICS**
September 1, 1956–September 1, 1957
University of Minnesota, Minneapolis 14
Contract Nonr-710 (22)

The work of the Atmospheric Physics Program in the period September 1, 1956 to September 1, 1957 consisted of the following subjects: infrared black ball, infrared radiometer, air temperature measurements, balloon physics and manufacture, air sampling, ionization measurements, and instrument development work.

A preliminary experiment on the infrared black ball has been made which attempts to clarify the problem, indicated by experimental data, that all objects, regardless of their spectral absorption, tend to run at approximately the same temperature difference from the air as does the black ball.

The infrared radiometer is a convection-free device developed to ascertain whether convection corrections can be made properly so that the black-ball readings may be converted to black-body radiation temperatures in the atmosphere. Flights made with this balanced radiometer and results obtained are reported.

A series of temperature flights was made using Lagrangian-type meteorological measurements. These flights also enabled a study to be made of the accuracy with which air temperature can be measured. Laboratory experiments were carried out to measure those parameters necessary to predict the performance of thermometers. Results of these experiments and flights are discussed.

The principal progress made in balloon physics and manufacture has been in a better understanding of the infrared properties of Mylar balloons and a better method of fabrication of Mylar tetroons.

High-altitude air samples were taken and analyzed for the He^3/He^4 ratio as compared with that existing at lower altitude.

Experimental procedure and equipment used in ion-density measurements are described and results are presented.

Instruments have been designed for application in the atmospheric physics measurements at high altitude, and descriptions of some of these instruments are included.

1,216 **REDUCTION OF FLIGHT TIME AND PROPELLANT REQUIREMENTS OF SATELLITE WITH ELECTRIC PROPULSION BY THE USE OF STORED ELECTRICAL ENERGY**

Camac, M. (AVCO Research Laboratory, Everett, Mass.)

November 17–21, 1958

American Rocket Society, New York 36, N. Y.

Paper 721-58

The paper analyzes flight plans for satellites having a lower thrust than the local gravitational forces. Electrical propulsion near the earth is a good example of such propulsion systems. The energy supply (either a reactor or solar collector) is fixed, and thus there is a maximum average power available for producing thrust. For such power-limited systems it has been suggested that the shortest flight time is obtained when the thrust acceleration is kept at a constant level. This gives the familiar spiral orbit for low-thrust vehicles. However, there was no consideration of the use of energy storage which allows much more freedom for programing the thrust while still utilizing all the available energy. It will be shown that with the incorporation of energy storage, flight plans can be achieved in some cases which reduce both the flight time and the propellant requirements. While the treatment is general for vehicles with thrust less than the local gravitational forces, only two types of missions have been analyzed in detail, both being in the gravitation field of the earth: (1) a trip from a small to a larger circular orbit and subsequent return to the earth, and (2) navigation between orbits at low altitudes (e.g., interception and rendezvous problems).

The minimum-impulse plan to go from a low circular orbit to a high-altitude orbit is accomplished with the Hohmann transfer ellipse, which requires two short impulses. The thrust acceleration required during these impulses is comparable to the local gravitational acceleration. For systems that operate at lower thrust levels, this flight plan cannot be achieved, and it is generally postulated that the thrust should be on continuously, thus producing a spiral orbit. The impulse required for this spiral-orbit flight plan is always larger than that required for the Hohmann transfer ellipse. With the incorporation of the electrical energy storage a flight plan can be achieved having a total impulse approximating that for the Hohmann transfer ellipse.

In almost all rendezvous problems the flight plans require that thrust be applied at only limited portions of the orbit. Energy storage will allow more utilization of the available energy and thus will substantially decrease the time for a given maneuver. Examples are presented of transfers between orbits in the same orbit plane as well as between planes at different orientations. Since relatively large impulses of short duration permit more accurate flight programing, the inclusion of energy storage would also simplify the guidance and control problems.

1,217 PRELIMINARY STUDIES ON ELECTRICAL PROPULSION SYSTEMS FOR SPACE TRAVEL
Fox, R. (University of California Radiation Laboratory, Livermore)
November 17–21, 1958
American Rocket Society, New York 36, N. Y.
Paper 708-58

A brief description of the flight mechanics of both low and high acceleration for interplanetary missions is presented. It is shown that the low-acceleration systems pay a large penalty in total momentum change requirements. An optimization procedure for low-acceleration systems is given which leads to a simple relationship between mission requirements, payload fraction, power-plant specific power, and exhaust velocity. The energy limitation for electric propulsion systems utilizing a nuclear energy source is described and shown to give an upper limit to the mission of about 2×10^5 m/sec for current technology. It is shown that electric propulsion systems with a specific power capability of 0.1 kw/kg can compete favorably with chemical or heat-exchanger-type nuclear–hydrogen rockets for a Mars mission and are much superior for missions to the outer planets. The hardware problems associated with the attainment of a specific power of 0.1 kw/kg for an electric propulsion system are described.

1,218 PERTURBATIONS OF THE FIVE OUTER PLANETS BY THE FOUR INNER ONES
Clemence, G. M.
1954
U. S. Naval Observatory
Astronomical Papers Vol. 13, Part V

The calculations in this paper are carried out to a high degree of precision. The effects of the four inner planets are considered separately. Only the first power of the disturbing mass is considered. The perturbations are divided into four classes: periodic direct perturbations, secular perturbations, constant perturbations, and indirect perturbations.

1,219 FIRST INTERNATIONAL CONGRESS ON AERONAUTICAL SCIENCES, MADRID
Anderson, J. B., Jr., and Liebowitz, H.
December 29, 1958
Office of Naval Research, London, England
Technical Report ONRL-97-58

Technical papers were presented which dealt with problems involved in high-speed flight in the fields of aerodynamics, structures, navigation and guidance, power plants, human engineering, and space flight. This report presents a list of the papers and abstracts the material.

1,220 **SURVEY OF SPACE LAW**
1958
U. S. Congress (85th), Second Session, Washington, D. C.

The legal status of space is a crisis problem brought about by the rapid advance in the capability of nations to explore and use outer space and by the ending, January 1, 1959, of the official influence of the IGY. To clarify the situation, Henry Cabot Lodge, the U. S. Representative to the UN, introduced a resolution in the General Assembly to study "the nature of legal problems which may arise in the carrying out of programs to explore outer space."

Basic questions that need solution are these: (1) What and where is outer space? (2) What shall man permit himself to do there? (3) How shall we legislate in this area?

The following steps have been recommended: (1) Begin now with the development of space law. (2) Identify and concentrate upon disputed areas showing some promise of settlement. (3) Attempt agreement on principles and on methods of settling disputes, leaving the specifics for a later date, when necessary. (4) Emphasize agreements on scientific and commercial uses of space, working from there toward the larger issues such as national sovereignty.

1,221 **INTERNATIONAL GEOPHYSICAL YEAR 1957-58**
July, 1958
National Academy of Sciences, National Research Council, Washington, D. C.

This report summarizes the U. S. program for the IGY up to July, 1958 and presents a résumé of activities in the fields of meteorology, geomagnetism, aurora and airglow observations, ionospheric physics, solar activity, cosmic rays, longitudes and latitudes, glaciology, oceanography, rockets and satellites, seismology, gravity, and nuclear radiation. The addresses of the World Data Center A in these fields are given. The report lists participating stations and the areas which each is investigating.

1,222 **SPECIAL COMMITTEE FOR THE INTERNATIONAL GEOPHYSICAL YEAR ADVISORY COMMITTEE ON PUBLICATIONS DRAFT REPORT TO BUREAU OF CSAGI ON IGY PUBLICATION PROGRAMME**
May 20, 1958
Special Committee for the IGY, France

The Advisory Committee on Publications for the International Geophysical Year has sought information from participating committees concerning their IGY publication plans. Replies from the participating committees are presented in an appendix.

1,223 AN OBSERVATORY IN SPACE
January 20, 1959
Defense Department, Office of Security Review,
Washington, D. C.

A proposal is presented for an earth satellite weighing 21.5 lb, of which 11 lb would be instruments. These instruments include a scientific experiment—such as an experiment to measure the intensity of solar radiation at the wavelength of Lyman α—telemetering apparatus to relay information to the experimenter, a radio beacon to provide a means for tracking, and the necessary power supplies. There is no weight available for aspect control; battery life would be only a few weeks. This experiment is a vast extension over the rocketborne experiments which stay at altitude but a few minutes.

1,224 INTERNATIONAL COOPERATION IN EXPLORATION OF SPACE
January 3, 1959
U. S. Congress (85th), Second Session
Washington, D. C.
H. R. 2709

The Select Committee on Astronautics and Space Exploration has been authorized to encourage an orderly program of development and exploration in the field of space and astronautics. To accomplish this, a series of studies has been originated which covers the basic problems involved in getting a sound, long-term policy under way. Studies include the prospect for international cooperation in the space effort.

The report of this study is divided into the following sections: (1) The Impetus to International Cooperation, (2) Opportunities for International Cooperation, (3) British Radio Astronomy: An Example, (4) The Amsterdam Conference, (5) The Soviet Attitude, (6) United States Security, (7) Space Propulsion: The Classic Problem, (8) Pioneer, Sputnik, and the Public Interest, (9) The Law of Space, and (10) Recommendations for an International Body.

1,225 PHOTOMETRIC OBSERVATIONS OF THE LUNAR ECLIPSE OF NOVEMBER 17–18, 1956
Bruner, E. C., Jr.
November 20, 1958
Naval Ordnance Test Station, China Lake, Calif.
NOTS TP 2142

Measurements of the brightness of the lunar disk were made in 2-wavelength intervals, centered at λ 5458 and λ 6230, during the lunar eclipse of November 17–18, 1956. The present measurements indicate that, at the center of totality, the brightness in the green changed by 11.4 magnitudes and the brightness in the red changed by 10.8 magnitudes from that of the uneclipsed moon.

1,226 **RESEARCH IN SPACE SCIENCE**
Jacchia, L. G., Davis, R. J., McCrosky, R. E., Bullis, E. P., and Campbell, L., Jr.
January 5, 1959
Smithsonian Institution, Astrophysical Observatory, Cambridge, Mass.
Report No. 20

The following articles are presented: (1) *An Empirical Formula for Satellite Ephemerides Near the End of Their Lifetime,* (2) *The Diurnal Effect in the Orbital Acceleration of Satellite 1957 Beta One,* (3) *Progress Report on the Planning of an Artificial Satellite Containing an Astronomical Telescope,* (4) *A Suggested Rocket Experiment for Determination of Atmospheric Densities and Winds at Extreme Heights,* (5) *Operation Information—on 1958 Zeta,* and (6) *Moonwatch Catalogue—September, 1958.*

1,227 **SATELLITE TRAJECTORY AND ORBIT CALCULATIONS FROM MINITRACK TRIANGULATION**
Kemper, W. A.
December 8, 1958
U. S. Naval Proving Ground, Dahlgren, Va.
NPG Report No. 1633

This work was undertaken to provide information on the performance of the Vanguard satellite-launching vehicles during the third-stage burning and also to provide a back-up prediction of the orbit or trajectory from simultaneous Minitrack data taken at Grand Turk and Antigua. The report describes the calculation procedures used and the results obtained through May, 1958. The calculations are made in 3 steps. First, position coordinates are obtained by a least-squares triangulation using simultaneous data from the two stations. Then a "best" fit is made to the position coordinates using orthonormal polynomials, and smooth position, velocity, and acceleration are obtained. With these data as initial conditions, trajectories are integrated around an oblate speroidal earth with a gravity field corresponding to the figure of the earth. Results are given for 1958 Alpha and Beta and for the orbit attempts of Explorer II and SLV I.

These results indicate that when the proper correction has been made to resolve the ambiguity in the data, these procedures may be applied to simultaneous Minitrack data from two stations where the satellite may be at a large zenith angle (up to 70 deg). Valuable data can be obtained on the trajectory during the last stage of burning, and good orbit or impact prediction can be made from as little as 10 sec of simultaneous Minitrack data after burnout.

1,228 SUMMARY OF DOPPLER SATELLITE TRACKING OPERATIONS DURING THE FIRST WEEK AFTER 1958 ALPHA LAUNCH

Bentley, B. T., Prenatt, R. E., and de Bey, L. G.
October, 1958
Ballistic Research Laboratories,
Aberden Proving Ground, Md.
Technical Note No. 1224

Operation of the BRL Satellite Tracking Station during launch and during the first week after launch of 1958 Alpha is discussed. Satellite signals were monitored for from 3 to 5 passes daily during the times of optimum radio reception for the first 7 days. Briefly described are the tracking instrumentation and data reduction. A tabulation of pass times, slant ranges, and transmitter frequency is included.

1,229 BASIC OBJECTIVES OF A CONTINUING PROGRAM OF SCIENTIFIC RESEARCH IN OUTER SPACE

Kellogg, W. W.
November, 1957
Rand Corp., Santa Monica, Calif.

A long-term space-exploration program is proposed having the basic goal of gaining knowledge about the solar system and the universe beyond.

The use of sounding rockets in upper-atmosphere research is discussed, and the type of information which should be collected is described.

The earth satellite can be used to observe only three kinds of phenomena: photons, particles, and fields. Experiments which could be done in satellite vehicles are presented in outline.

Lunar investigations—mainly circumlunar probes which can gather information about the moon as a whole—are described as to technical development and state of scientific research. The kinds of information which could be gained from impact points or landings are mentioned.

A discussion is included of planetary and interplanetary investigations and of the problems of tracking, communication, planetary landings, and manned space flight.

1,230 **MINIMAL IMPULSE REQUIREMENTS FOR DISORBITING SATELLITES**
Blumenthal, I. S.
October 15, 1958
Rand Corp., Santa Monica, Calif.
RM-2276 (ASTIA AD-209,422)

This report presents a quantitative determination of the minimal velocity impulse which must be imparted to satellites on circular and elliptic orbits in order to "knock" them out of orbit and to impact the earth. It is pointed out that if it were feasible this would be equivalent to shooting down a satellite and would be a highly desirable form of defensive counteraction since it would avoid the necessity for damage assessment.

Results are presented for all points on circular orbits, and the range of requirements for elliptic orbits is bracketed by considering impulses delivered only at apogee and perigee. The method of analysis is based on the important concept of equivalent energy orbits, which is discussed in an appendix.

It is observed that for a 300-nm circular orbit, the rearward velocity impulse required is 500 fps. For very elliptic orbits the disorbiting impulse required at apogee is an order of magnitude less than that required at perigee. A physical mechanism for imparting these impulses is not described but some idea of the fundamental problems involved is presented in the discussion of the energy exchanges which must occur in one postulated scheme.

1,231 **CHARACTERISTICS OF MOON-REFLECTED UHF SIGNALS**
Fricker, S. J., Ingalls, R. P., *et al*
December 22, 1958
Lincoln Laboratory, Lexington, Mass.
Technical Report No. 187

A UHF (412-mc) CW bistatic moon-reflection experiment is described in which measurements were made of the total received power, the faraday rotation, the doppler shift, and the fading rate of the moon-reflected signals. From the results, an effective radar cross-sectioned area of the moon was estimated to be 7×10^{11} square meters. An explanation for the cause of the rapid fading of the signal, based on dynamical considerations alone, gives numerical results that agree well with the measured fading rates.

1,232 AROUND THE MOON IN EIGHTY HOURS
Cole, D. M., and Muir, D. E.
August 19, 1958
The Martin Company, Denver, Colo.
M-M-P-58-42

A conceptual design of a manned circumlunar vehicle for the early 1960's is presented, showing how early availability and low cost can be achieved by making maximum use of ICBM hardware and facilities. Results of orbit, space medicine, and re-entry studies critical to the circumlunar flight are included.

1,233 BIOASTRONAUTICS ADVANCES IN RESEARCH
March, 1959
School of Aviation Medicine, Randolph AFB, Texas

A compilation of papers is presented dealing with various aspects of the effects of space travel on primates and the use of plants in space research. Titles and authors are as follows: *Definitions and Subdivisions of Space (Bioastronautical Aspect)*, H. Strughold; *Bio-Paks-Instrumentation and Biomedical Research; Primates in Space; Center of Gravity and Moments of Inertia Measurements for Seat Plus a Rhesus Monkey*, H. G. Claman; *Summary of Immunochemical Analyses on Sera from Humans Exposed in a Simulated Altitude Chamber*, W. G. Glenn; *Survival of Terrestrial Micro-Organisms Under Simulated Martian Conditions*, J. D. Fulton; *Photosynthetic Gas Exchangers and Recyclers Used in Closed Ecological System Studies*, W. A. Kratz; *Man in Space*, B. Balke; *Physiologic Instrumentation of Man During Flight*, C. H. Kratochvil; and *Carbon Monoxide Phenomena in Green Plants' Systems*, S. S. Wilks, R. M. Adams, *et al.*

1,234 SOME OF THE RESULTS OF SCIENTIFIC RESEARCHES ON THE FIRST TWO SOVIET ARTIFICIAL EARTH SATELLITES
June 10, 1958
National Academy of Sciences, Washington, D. C.
Memo TP-21

This report is a translation of a communication from the USSR on the scientific results of the first two Soviet artificial earth satellites launched on October 4, 1957 and November 3, 1957.

Data is given on results of radio and optical observations of the satellites. The doppler effect was utilized to determine the parameters of the satellites' orbits. Optical observations were made with special photocinetheodolites and photographs of the satellites' tracks were obtained with modernized aerophotocameras. The most successful method of photographing was the operation with electro-optical interferometers.

Air-density and temperature measurements were obtained from observations of the satellites' orbits. The rate of decrease in density is characterized by a "height of homogeneous atmosphere," which is proportional to air temperature and inversely proportional to its molecular weight. Density measurements proved 5 to 10 times greater than the values originally assumed. Air temperature derived from the received data is greater than had been theoretically assumed.

Data received in the observations of radio signals transmitted from the satellites indicated that electron-density values in the outer ionosphere (above the main maximum) decreases with altitude 5 to 6 times slower than it increases below the maximum. Cosmic ray data showed that from an altitude of 225 to 700 km the intensity of radiation increases by approximately 40%.

Data from the biological investigation carried out in Sputnik II indicated that the animal withstood the physiological effects of acceleration without too much difficulty; however, the phenomenon of weightlessness prevented it from returning to normal as quickly as in laboratory experiments.

1,235 PROPOSAL FOR METHOD OF DETERMINING AMOUNTS OF K^{40}, URANIUM, AND THORIUM IN THE NEAR-SURFACE LAYERS OF THE MOON
March 20, 1959
Texas Instruments Inc., Dallas, Texas,
Central Research Laboratories
Proposal No. 5-R59

Knowledge of the amount of radioactive material in the near-surface layers of the moon is highly desirable. Measurements of the amounts of potassium, uranium, and thorium on the lunar surface should indicate whether the moon has undergone a crustal evolution similar to that of the earth.

Spectral information throughout the flight of a space vehicle could be monitored to ascertain the energy levels present along the flight path. This information would then indicate radiation levels in the region about the earth and provide information as to the existence of a similar region about the moon. The objective of this proposal is to outline a method for obtaining the spectral analysis of radiation present on the lunar surface and for telemetering this information to earth.

1,236 THE ATTAINABILITY OF THE STARS
Sanger, E.
Schamberg, R., translation
December 26, 1956
Rand Corp., Santa Monica, Calif.
T-69

The yet hypothetical quantum rockets have jet velocities equal to the velocity of light, which allows their flight velocities to approach the optic velocity. From the laws of classical mechanics, it would follow that the limited human lifetime and the limited mass ratio of the rocket would permit ranges of some tenths of light years, i.e., over a very limited part of our galaxy and to the very nearest fixed stars only.

However, from the laws of relativistic mechanics there follows for those very near optic-velocities a considerable dilation of proper time on board the vehicle relative to terrestrial time; life of the crew and action of the rocket motor would be slower than at the terrestrial time scale.

This means that within the life-span of the crew and with limited mass ratios of the rocket, every thinkable distance in space can be covered, so that, expressed in technical terms, the vehicle seems to be able to move with considerable super optic-velocity.

1,237 THE ARTIFICIAL COMET
Shklovsky, I. S.
***Pravda*, January 18, 1959**
Zygielbaum, J. L., translation
February 2, 1959
California Institute of Technology, Pasadena,
Jet Propulsion Laboratory

This report describes the methods available for determining the orbit of a cosmic rocket. Proper means of observation of its position in interplanetary space is essential to such a determination. This may be done by a radio-physical and an optical method.

Optical observation is extremely difficult since the intensity of the reflected solar light is inversely proportional to the square of the distance and the rocket would appear as a very small star with the background of a fairly bright star. To circumvent this difficulty, resonance fluorescence was applied to the rocket. The rocket was equipped with an evaporator, utilized in the formation of a cloud of atomic sodium. Thermite, which ignites at a predetermined moment, was used in the evaporation process.

Special cameras were prepared to observe the ignition. Two series of luminous cameras, photographic and electrotelescopic, were prepared and supplied with high-quality interference light filters. These were placed at several points in the Soviet Union and proved highly successful.

1,238 SATELLITE RE-ENTRY DISCUSSION OF RETRIEVING SYSTEMS AND CONTROL CONSIDERATIONS
August 8, 1958
Army Ballistic Missile Agency, Redstone Arsenal, Huntsville, Ala.
Report No. DA-TN-51-58

The mechanics of re-entry and retrieval of a satellite vehicle are discussed. An investigation is made of the characteristics of the transfer ellipse dependent on the angular alignment and magnitude of the retrieving impulse exerted on the missile in high altitude to initiate the descent.

The sensitivity of the re-entry characteristics, especially of the ground range, with variations of the kick parameters is numerically studied.

A method is described for determining the azimuth of launching required for achieving an opportunity of impacting in a predetermined impact area within a given time.

Possible modes of controlling the altitude of the satellite at the recall point are discussed with two and three degrees of restrictions.

A special simple case of descent from an orbital altitude of 300 km within 30 hours after injection is presented. An error analysis is carried on which shows that the impact can be predicted within 25 km from a nominal point which is precalculated while the orbiter is in flight.

1,239 DERIVATION AND CALCULATION OF INITIAL VALUES OF MOON-HITTING TRAJECTORIES
Ruppe, H., and Straly, W.
May 30, 1958
Army Ballistic Missile Agency, Redstone Arsenal, Huntsville, Ala.
Report No. DSP-TM-3-58

A rapid and simple method of calculating the initial data for earth–moon flight paths has been devised. If the time and date of impact on the moon are known together with flight time and launching place, this method enables calculation of the approximate launching time, injection angle, and azimuth. The report is intended as an aid in computing such values without the use of an electronic computer.

1,240 ORBITAL RESULTS FOR SATELLITE 1957 BETA ONE
Jacchia, L. G.
May 21, 1958
Smithsonian Institution, Astrophysical Observatory, Cambridge, Mass.
Special Report 13

This report tabulates the results of a study of the orbital behavior of 1957 Beta One and covers the complete lifetime of the satellite. The raw data were gathered from radio, visual, and photographic observations conducted at hundreds of stations around the world. Methods of data reduction are explained.

1,241 **EARTH SATELLITE OBSERVATIONS MADE WITH THE MILLSTONE HILL RADAR**
Pettengill, G. H., and Kraft, L. G., Jr.
Massachusetts Institute of Technology, Cambridge, Lincoln Laboratory
JA-1128

The Millstone Hill radar facility of the Lincoln Laboratory was designed as a research tool in the study of high-power radar techniques and has found extensive application to the detection and tracking of earth satellites. The parabolic antenna measures 84 ft from rim to rim and is 90 ft above ground level. At the operating frequency of 440 mc, the half-power beamwidth is 2-deg.

A table is presented which summarizes the electrical parameters of the radar system as most commonly used in satellite tracking. Another table gives the peak radar cross section of several artificial earth satellites for vertical transmitted polarization. The feasibility of a measurement of pulse-to-pulse phase is discussed.

The calibration of the various instruments used to make measurements with the Millstone radar facility generally consists of two steps: (1) internal signals or secondary measurements are used to establish a calibration; (2) the entire system is checked out against a known target at a known position.

1,242 **ADVANCED PROPULSION SYSTEMS FOR SPACE VEHICLES**
Stuhlinger, E.
August, 1958
Army Ballistic Missile Agency, Redstone Arsenal, Huntsville, Ala.

A number of propulsion systems are compared with respect to their usefulness as space vehicle motors. Initial mass is of prime interest. A lowest acceleration of the vehicle of about 5×10^{-5} g would be acceptable. Below that limit, the capability for maneuver and trajectory corrections would be insufficient. The duration of propulsion depends on the propulsion system. It may vary between a few hours and the full time of interplanetary flight.

The systems described are: chemical systems, which are now in use and whose performance is limited by the energy content of the propellants; solar-heated systems, which require large mirror systems to concentrate the solar energy on the heating elements; nuclear-heated systems; arc-heated systems; plasma jets; and electrostatic ion systems, wherein the propellant atoms are first ionized and then are subjected to the accelerating force of an electrostatic field.

The chemical system has the advantage of being the best known and could be used for interplanetary travel. The solar-heated hydrogen-propelled ship may find application in missions of short duration. Arc-heated systems may prove not altogether attractive unless the major part of the energy can be drawn from a fusion reaction within the thrust chamber. Plasma jets are promising if the mass of condensers, magnetic-field coils, and magnetic-field power supply can be kept sufficiently small. Electrostatic propulsion systems appear feasible and, with respect to the ratio of payload to initial mass, very economical.

1,243 **PRELIMINARY CONSIDERATION ON THE INSTRUMENTATION OF A PHOTOGRAPHIC RECONNAISSANCE OF MARS**
Laning, J. H., Jr., Frey, E. J., and Trageser, M. B.
April, 1958
Massachusetts Institute of Technology, Cambridge, Instrumentation Laboratory
Report R-174

The present technical feasibility of an unmanned photographic reconnaissance flight to the planet Mars is discussed. The basic problem of navigation appears to be met by equipment in which errors of 0.1% in measurement of acceleration and of 10 to 20 sec of arc in optical-line-of-sight data are tolerable. The variety of tasks to be performed would seem to call for a general-purpose digital computer as the central control organ for the vehicle, and the development of such a computer with sufficiently low weight and average power requirements is one of the principal technical problems.

The primary purpose of the mission is considered to be that of obtaining a series of close-up photographs of the surface of Mars from, say, an altitude of 4000 miles above its surface. Recovery of the films on earth by a suitable re-entry vehicle is postulated. Consideration is also given, from the standpoint of guidance accuracy required, to the launching of a small vehicle that might descend to Mars' surface.

Suitable trajectories for the flight are considered, as are the navigational error problem which might arise, the types of equipment that might comprise the final vehicle, and the various missions that a vehicle of this type could perform.

1,244 **NOTES ON "POSSIBLE USES OF EARTH SATELLITES" SYMPOSIUM**
Duryee, W. R., and Finan, J. L.
August 6, 1958
National Academy of Sciences, Washington, D. C.
Memo TP-28

This document is a brief summation of the symposium held in Washington on May 14–17, 1958, pending publication of the complete proceedings by the University of Michigan Press.

The purposes of the conference are:

1. To stimulate thinking which will lead to a sound program of scientific research in the life sciences involving the use of earth satellites directed toward both broad objectives in the life sciences and an ultimate goal of manned space flight.
2. To exchange information concerning the technical feasibility and scientific importance of various experiments in the satellite environment.
3. To discuss methods and techniques for conducting such experiments, including associated laboratory work.

Papers were presented on the Army, Navy, and Air Force Satellite and Space Flight Programs along with reports and data on experiments which will help put man into space.

1,245 **DESIGN PARAMETERS AND OPTIMIZATION OF MISSILE TRAJECTORIES**
Traenkle, C. A.
September, 1958
Wright Air Development Center, Wright-Patterson AFB, Ohio, Aeronautical Research Laboratory
Technical Report 58-580 (ASTIA AD-204,805)

This paper analyzes, step by step, the variables and design parameters that characterize the performance of missiles with regard to range, power-phase programs, propellant mass, and the ratio of take-off weight to pay load. This analysis leads to a clear insight into optimal design procedures and parameters. The power-phase program, according to the "glide up scheme," always achieves a superior propellant economy. Below the critical range angle ϕ^*_{cr} of about 50 deg, i.e., for intermediate ranges, the optimal conditions are met by ballistic trajectories. Above ϕ^*_{cr}, the optimal conditions are indicated by the special orbit $k = 1$, which calls for satellite speeds and therefore for a different treatment. Numerical results are given for the example of conventional chemical propellants, but the methods are applicable to propulsion systems using other sources of energy.

1,246 **SATELLITE VEHICLE–1958 ZETA (THE WEEKLY PREDICTIONS OF THE ORBIT FOR SATELLITE 1958 ZETA)**
January 19, 1959
Smithsonian Institution, Astrophysical Observatory, Cambridge, Mass.

1,247 OPTIMAL PROGRAMMING AND CONTROL OF SATELLITE ORBITS
Traenkle, C. A.
September, 1958
Wright Air Development Center, Wright-Patterson AFB, Ohio, Aeronautical Research Laboratory
Technical Report 58-581 (ASTIA AD-204,806)

Remarkable gain in the take-off weight of satellite vehicles can be attained by appropriate launch programs, specifically by tangential ascent and combined skim launching; compared with the conventional zero-angle-of-attack launch program, the payload may be increased for a given take-off weight by the factor which depends on the launch angle and is considerably greater than 2 for extreme cases. Further points are the investigation of the descent mechanics, including the design of optimal programs and the analysis of proximity and skim orbits, as applied to intermediate and long-range haul.

1,248 MECHANICS OF THE POWER AND LAUNCHING PHASE FOR MISSILES AND SATELLITES
Traenkle, C. A.
September, 1958
Wright Air Development Center, Wright-Patterson AFB, Ohio, Aeronautical Research Laboratory
Technical Report 58-579 (ASTIA AD-204,804)

The mechanics of missile and satellite launching are analyzed by breaking down the problem to its essential variables and reducing it to the integrable form of the "reference trajectory." Various practical power programs are analyzed with respect to their characteristic parameters, their interrelation with optimal composition theorems, and their end velocities and energy content. These include: (1) a constant attitude program, representing the case with no atmosphere, which is employed as a reference case, (2) a zero-angle-of-attack program, commonly used in practice, which can be characterized by a single parameter C, determining primarily the rate of turn initiation, and (3) a straight line program, the "glide up scheme," employing an aerodynamic lift force. This program results in remarkable fuel economy. The efficiencies of the various power programs are compared by means of a "stretch factor ε," giving a convenient and rapid tool for establishing a figure of merit. Rapidly converging iterative integration methods are set up, accounting for the perturbation terms that are neglected in the first step approximation of the reference trajectory. Thus the end results can be refined to any degree of accuracy. Further potential applications are envisaged and discussed.

1,249 **ELEMENTARY PROPERTIES OF CONIC-SECTION PROBE ORBITS**
Lorell, J.
February, 1959
California Institute of Technology, Pasadena,
Jet Propulsion Laboratory
Library, No. 73

For probe orbits, the first approximations to required velocity, time of flight, distance to aphelion or perihelion, etc., can often be calculated by means of the conic-section formulas. The purpose of this paper is to summarize some of the situations in which the conic-section formulas are useful. A few numerical results are included.

1,250 **THE USE OF AERODYNAMIC LIFT DURING ENTRY INTO THE EARTH'S ATMOSPHERE**
Lees, L., Hartwig, F. W., and Cohen, C. B.
November 20, 1958
Ramo-Wooldridge Corp., Los Angeles, Calif.,
Space Technology Laboratories
GM-TR-0165-00519

By employing aerodynamic lift during entry into the earth's atmosphere at either orbital or escape velocity, the range of allowable entry angles for a prescribed peak deceleration is greatly increased, while the total heat energy transferred to the vehicle can be held to about the same value as that for a nonlifting vehicle. Only modest lift–drag ratios are required beyond peak g to prevent the deceleration from exceeding the peak value or to prevent the vehicle from skipping out of the earth's atmosphere. Thus the difficult guidance and control problem is greatly alleviated; in particular, for return from the moon or from other planets the necessity for multiple-pass dragbraking is eliminated.

1,251 **THE USE OF DRAG MODULATION TO REDUCE DECELERATION LOADS DURING ATMOSPHERIC RE-ENTRY**
Phillips, R. L., and Cohen, C. B.
April 9, 1958
Ramo-Wooldridge Corp., Los Angeles, Calif.,
Space Technology Laboratories
GM-TR-0165-00352

The design of a space vehicle capable of entering the earth's atmosphere involves, among other things, consideration of the accuracy with which its landing point can be predicted, the maximum deceleration loads which the vehicle will experience, and the aerodynamic heating to which the vehicle is exposed. Since minimization of the landing-point dispersion may require the use of entry angles sufficiently large to cause subsequent excessive deceleration loads to the vehicle and its occupants, a scheme is examined whereby these loads may be reduced to a tolerable level. This is accomplished by variation of the drag of the vehicle (either discretely or continuously) in a properly programmed fashion. It is found that the use of continuous drag modulation can reduce the deceleration loads by as much as 50% without significantly affecting the total aerodynamic heating of the vehicle. Particular numerical solutions of the complete equations of motion are also included. These substantiate the results of the approximate analysis. In addition, several specific applications of drag modulation have been considered, such as application to a vehicle returning from the moon.

1,252 **DETERMINATION OF ATMOSPHERIC DENSITY FROM OBSERVATIONS OF THE FIRST SPUTNIKS' DRAG**
(Paper presented at the Rocket and Satellite Symposium during the Fifth Reunion of the Comité Special Année Géophysique Internationale held in Moscow, July 30–August 9, 1958)
Lidov, M. L.
National Academy of Sciences,
National Research Council,
Washington, D.C.

This paper deals with the results of the calculations to determine the atmospheric parameters by the Sputniks' drag.

1,253 **INVESTIGATION OF IONOSPHERE NON-UNIFORMITIES BY RADIO ASTRONOMICAL METHODS**
Vitkevich, V. V.
Palmer, J. W., translation
***Radiotekhnika I Elektronika*, 3 (No. 4): 478-486, 1958**
November, 1958
Royal Aircraft Establishment
Library Translation No. 788

When investigating electron nonuniformities in the ionosphere, use is made of the method of radio radiation of "radio stellae." The dimensions and electron concentration of large-scale nonuniformities are calculated from data on the irregularities of vertical ionosphere refraction. Data are given of irregularities of horizontal radio refraction and also of electron nonuniformities which disturb the interference picture.

1,254 APPLICATION OF THE SIMPLIFIED PHASE PLANE TO THE ANALYSIS AND DESIGN OF MISSILE JET-RELAY CONTROL SYSTEMS
Hieatt, J. L.
September 30, 1958
U.S. Naval Research Laboratory, Washington, D.C.
Proj. Vanguard Report 34; NRL Report 5216

The application of phase-plane analysis to a missile jet-relay control system is reviewed, explained, and illustrated. Only a single lead network is considered under conditions in which aerodynamic damping is negligible. The assumption that all forces occur as step inputs is used to simplify analysis techniques and does not constitute a significant limitation on the application of this method for design purposes.

To aid in system design, an analytic method for the solution of phase-plane plots is developed. The analytic technique reduces the time necessary to evaluate a system design by minimizing the necessity for construction of phase-plane diagrams.

A summary of general principles which may be used to optimize a missile jet-relay control system is presented.

1,255 PROCEEDINGS OF LUNAR AND PLANETARY EXPLORATION COLLOQUIUM
October 29, 1958
Missile Division, North American Aviation, Inc., Los Angeles, Calif.
Vol. 1, No. 3

The following papers presented at the conference are concerned with analyses and observations of the moon and the planets: *The Chemistry of the Moon,* H. C. Urey, *Chemical Resources on the Moon,* H. Brown, *Power for a Lunar Colony,* M. O'Day, *Where to Land on the Moon,* C. Tombaugh, *Observations on Mars and Venus,* R. S. Richardson, *Gamma Ray Spectroscopy of the Moon's Surface,* J. R. Arnold, *Program of Lunar and Planetary Experiments,* S. M. Greenfield, and *The Crater Linné,* D. Alter.

1,256 RAYLEIGH'S PROBLEM IN A TRANSVERSE MAGNETIC FIELD
Yang, H. T.
December, 1958
University of Maryland, College Park
Tech. Note BN-158; AFOSR TN 59-47 (ASTIA AD-209, 418)

The purpose of the present study is to investigate Rayleigh's problem of an infinite flat plate suddenly accelerated from rest to uniform motion in a transverse magnetic field. The study of this problem, being closely related to that of boundary layer flow, will shed some light on the uniform motion of a flat plate through an electrically conducting fluid.

The conventional fundamental equations of magneto-fluid dynamics will be used with the following two main assumptions: (1) Maxwell's equations for the electromagnetic fluid hold; hence the electromagnetic energy is localized in the field and is not carried by the moving gas. (2) The flow velocity is small compared to the speed of light, so that displacement currents and excess electric charges may be neglected.

1,257 THEORY OF THE MOTION OF ARTIFICIAL SATELLITES, III
Kopal, Z.
October, 1958
University of Wisconsin, Madison, Mathematics Research Center
MRC Technical Summary Report No. 52

A complete mathematical analysis of the interaction between the earth's rotation and the tides has been made. A geometric analysis of the problem of interaction between the polar flattening produced by given centrifugal forces and tides raised on a rotating configuration by an arbitrary external field is presented. After the geometrical preliminaries are completed, the formulation of the specific form of second-order Clairaut's equations is made. Interaction terms for the external form and the exterior potential are expressed, and the Clairaut equations for these terms are set up.

The specification of the external potential as well as the form (or surface gravity) of a fluid configuration of arbitrary internal structure, distorted simultaneously by rotation and tides to the second order in terms of the superficial distortion is then completed.

1,258 SATELLITE 1959 ALPHA II (The weekly predictions of the orbit for satellite 1959 ALPHA II)
March 10, 1959
Smithsonian Institution, Astrophysical Observatory,
Cambridge, Mass.

1,259 **FEASIBILITY OF OBSERVING AND TRACKING A SMALL SATELLITE OBJECT**
October 18, 1955
Varo Manufacturing Company, Inc., College Park, Md.
Technical Report Contract NONR-1641(00)

This report summarizes studies of the observation and tracking of a small satellite able to withstand 250 *g* and having a maximum weight of 5 lb, and a diameter of 20 in.

The studies consider possible methods of observation, specify physical characteristics of the satellite, delineate and evaluate goals attainable, correlate goals with orbital inclination, and describe required tracking and computational facilities.

The problem of tracking an inclined orbit is considered in some detail, both for commensurate periods of 1/15 day and 1 day and for incommensurate periods approximating 1/15 day. Inclinations of 45 and 90 deg are specifically considered. It is concluded that the tracking can be done most practically by cinetheodolites, the initial orbit being determined by photographic ballistic cameras.

The primary factors limiting optical brightness are discussed; various methods of increasing the brightness are considered impractical. Radar and infrared techniques are not considered feasible for tracking; visual observation is considered most feasible from the standpoint of available equipment.

Various methods and forms for expanding a satellite to improve its visibility, both optical and radar, are discussed.

A description is given of several systems of satellite-borne radio transmitters and ground-based receivers.

1,260 **PROGRESS IN UPPER ATMOSPHERE PHYSICS DURING THE LAST DECADE**
June 30, 1957
University of California at Los Angeles,
Institute of Geophysics
AFCRC TR 57-213 (ASTIA AD-133,688)

Various means of investigating the physical state of the upper atmosphere of the earth are discussed. They are classified according to information source: rocket flights, meteor observations, sound propagation, etc. Each method is described briefly, and typical results concerning temperature, pressure, density, composition, winds, etc., are given. A distinction is made between the physical quantities which can be measured directly and those which can only be deduced from observations and theories. Tables, graphs, and literature references are included.

1,261 RECOVERY OF A CIRCUM-LUNAR INSTRUMENT CARRIER
Gazley, C., Jr., and Masson, D. J.
August 19, 1957
Rand Corp., Santa Monica, Calif.
P-1119

The possibility of the physical recovery of a circumlunar vehicle widens the scope of scientific investigations possible for a vehicle with lunar capabilities. While a very high guidance capability is necessary to impact such a recoverable vehicle within a given area on the earth's surface, only moderate accuracy is required for a return to earth. Radio tracking during return would enable prediction of the approximate impact point. Ultimate recovery could be accomplished through a radio beacon and overflight search.

While the penetration of the earth's atmosphere involves more severe decelerations and heating than in the case of the recovery of a scientific satellite, the magnitude of the deceleration poses few structural difficulties, and the use of a vaporizing surface for heat absorption does not imply excessive weight.

1,262 NEWS OF THE STUDY OF COSMIC RAYS
Vyernov, S., and Chudakov, A.
Pravda, March 6, 1959
Zygielbaum, J. L., translation
March 12, 1959
California Institute of Technology, Pasadena,
Jet Propulsion Laboratory

Cosmic rays were first discovered during the flights of aerial balloons, and much effort has been expended by the Soviets in investigations of ionization and the degree of radiation danger at various distances from the earth.

Radiation danger is concentrated in two zones; the danger is minimal close to the earth and at distances beyond 9 earth radii.

Results of investigations show that at distances up to 50,000 km, large quantities of electrons revolve around the earth. The energy of these electrons is comparatively small below 100,000 electron volts, and can be absorbed by relatively thin layers of material.

1,263 SPACE TRAVEL: PROBLEMS AND PROSPECTS
December, 1958
Wright Air Development Center, Wright-Patterson AFB, Ohio,
Wright-Patterson Technical Library

This publication is a bibliographical listing of books and articles dealing with space travel. Much of the material was originally presented by the American Rocket Society, the Institute of the Aeronautical Sciences, and the Society of Automotive Engineers.

1,264 **ORBITAL STORAGE OF CRYOGENIC FLUIDS**
Cramer, K. R.
October, 1958
Wright Air Development Center,
Wright-Patterson AFB, Ohio
WADC Technical Note 58-282 (ASTIA AD-203,527)

A radiative-heat-transfer analysis of large spherical liquid-hydrogen storage vessels located in an equatorial orbit is presented. The results demonstrate that simple multilayer reflective-type shielding is sufficient to maintain moderate yearly losses of liquid hydrogen. It is concluded that research specifically in the heat-transfer area is not required for the development of suitable storage containers.

1,265 **TWO PROBLEMS OF IMPULSE MINIMIZATION BETWEEN COPLANAR ORBITS**
February 12, 1959
Army Ballistic Missile Agency, Redstone Arsenal, Ala.
Technical Memo No. 23-59; Report No. DA-TM-23-59

This report answers two questions pertaining to space-flight performance: (1) "In what situations is it impulse-wise preferable to obtain elliptical orbits instead of circular orbits?" (2) "Given that it is desired to obtain an elliptical orbit, should the transfer ellipse be used to transfer into the perigee or apogee of the final orbit?"

The analysis covered is divided into two sections: (1) comparison of the high apogee ellipse and the circular orbit, and (2) comparison of terminal junction at apogee and terminal junction at perigee. Equations and diagrams are presented for the analysis.

1,266 **A PROBLEM IN SPECTRUM ESTIMATION**
Swerling, P.
August 8, 1958
Rand Corp., Santa Monica, Calif.
RM-2273 (ASTIA AD-209,537)

A discussion is made of a problem in spectrum estimation having a possible application to space-flight navigation. Several cosmic radio noise sources have been discovered for which the noise power density is approximately uniform except for an absorption band in the neighborhood of 1,420 mc; the width of one of the main dips in the band is typically 25 kc.

The structure of the frequency spectrum could be extensively analyzed in laboratories on the earth. Then, in a space vehicle, the radio source could be observed and the doppler shift of the absorption band measured with respect to some standard reference condition. Several such measurements from different radio sources could be used to gain information about the space vehicle's velocity.

The bulk of the analysis is devoted to the question of how accurately the doppler shift of such an absorption band can be measured for observed samples having various lengths. It is supposed that a sample function $N(t)$ of a stationary Gaussian random process $\{N(t)\}$, having zero mean, is observed for a finite length of time. The power spectrum of $\{N(t)\}$ is assumed to belong to a family of functions $F_h(\omega)$, where $F_h(\omega) = F[\omega(lh)]$, and $F(\omega)$ is a completely specified, even, non-negative, square integrable function of ω. The problem is to estimate h.

Formulas are derived for the mean and variance of estimates belonging to a certain class of estimates of h. Modifications of these formulas are given for the case where the spectrum shape $F(\omega)$ is imperfectly known.

An illustrative numerical example is given, and a possible application to space-flight navigation is pointed out.

1,267 ON THE PROBLEMS OF RE-ENTRY INTO THE EARTH'S ATMOSPHERE
Robinson, A. C., and Besonis, A. J.
August, 1958
Wright Air Development Center,
Wright-Patterson AFB, Ohio,
Aeronautical Research Laboratory
WADC Technical Report 58-408 (ASTIA AD-203,790)

Re-entry into the earth's atmosphere has been studied from the standpoints of deceleration, heating, and accuracy of impact. This has been done for re-entry speeds consistent with return from near satellite orbits, and for speeds consistent with re-entry from a circumlunar orbit under several configurations of lift and constant or variable-drag-coefficient assumptions. Heating considerations are based only on stagnation-point influences. It is shown that deceleration and peak heating rates are not larger than those occurring in ballistic missile re-entries. The total heat input, however, is much larger as the heating occupies a much longer time. It appears that simple nonlifting re-entry will be feasible from satellite orbits. The lunar re-entry, on the other hand, presents a severe total heat problem, and accuracy requirements are such that some lift or other control will probably be required.

1,268 DETERMINATION OF LONGITUDE, LATITUDE, AND AZIMUTH
Hoskinson, A. J., and Duerksen, J. A.
1952
U.S. Department of Commerce, Washington, D.C.
Special Publication No. 237

The purpose of this publication is to set forth the methods currently used by the Coast and Geodetic Survey in its work in the astronomical field and to describe in some detail the office methods used in computing and processing the field records. Processes discussed are divided into three parts: (1) determination of longitude, (2) determination of latitude by the Horrebow–Talcott method, and (3) determination of the astronomic azimuth of a direction.

1,269 **A STUDY OF ON-SITE COMPUTING AND DATA PROCESSING FOR A WORLD TRACKING NETWORK**
Gates, C. R., and Johnson, M. S.
February 9, 1959
California Institute of Technology, Pasadena,
Jet Propulsion Laboratory
Publication No. 154

The purpose of this study is to formulate requirements for operations to be performed on tracking or antenna-acquisition data at the individual sites of a world tracking network. The study begins with the basic question as to whether on-site data processing and computing are either necessary or desirable. A treatment of the mathematical operations to be performed and a description of the equipment required are presented. The data-transmission or channel-capacity requirements resulting from the study are given.

1,270 **PRELIMINARY REPORT ON LAUNCHING IN THE USSR OF THE FIRST AND SECOND ARTIFICIAL EARTH SATELLITES**
February 14, 1958
National Academy of Sciences, National Research Council,
Washington, D.C.

1,271 **OPTIMIZATION OF SPACE VEHICLE DESIGN WITH RESPECT TO PROPULSION SYSTEM**
Sandorff, P. E.
July 1, 1958
Massachusetts Institute of Technology, Cambridge,
Aeronautical Engineering Department
AFOSR TN 58-580 (ASTIA AD-158,402)

An analysis of space-vehicle design incorporating the propulsion system has been made. All components of the problem are considered and over-all cost factors are optimized. Penalties to be incurred by departing from this optimumization are discussed.

1,272 **THEORY OF THE MOTION OF ARTIFICIAL SATELLITES, IV**
Kopal, Z.
January, 1959
University of Wisconsin, Madison
MRC Technical Summary Report No. 70

An investigation is made of the formal properties of the functions governed by fundamental differential equations as are inferred from the structure of these equations for an arbitrary distribution of density. The investigation has three specific objectives: (1) to establish the explicit form of asymptotic solutions of Clairaut's equation appropriate for an arbitrary distribution of density in the interior of a fluid configuration exhibiting a weak degree of central condensation, (2) to establish iterative solutions appropriate for arbitrary configurations whose central condensations are high, and (3) to consider the complete solutions of equations more general than the fundamental differential equation and having an arbitrary function of central distance a on the right-hand side.

1,273 **A TECHNICAL DESCRIPTION OF SIERRA SAM AND FAMILY: TEST DUMMIES**
Sierra Engineering Co., Sierra Madre, Calif.

This is a descriptive report concerning the anthropometric and anthropomorphic test dummies built by the Sierra Engineering Company. Complete information is given on the construction and use of the four primary models available. Diagrams and photographs are included.

1,274 **INVESTIGATION ON THE POSSIBILITY OF ESTABLISHING A SPACE SHIP IN AN ORBIT ABOVE THE SURFACE OF THE EARTH**
Lancaster, O. E., and Moore, J. R.
November, 1945
Navy Department, Washington, D.C., Bureau of Aeronautics
A.D.R. Report R-48

A theoretical analysis has been made to determine the possibility of placing a space ship in orbit about the earth. Sample calculations have been made for a particular orbit, employing available fuels, for both single-stage and multistage rocket ships. The calculations are somewhat optimistic since orbital velocity was considered to be only 10,255 mi/hr.

1,275 ASTRONOMICAL EXPERIMENTS PROPOSED FOR EARTH SATELLITES
Aller, L. H., Goldberg, L., Haddock, F. T., and Liller W.
November, 1958
McDonnell Aircraft Corp., St. Louis, Mo.
UMRI Project 2783

This report lists and describes a number of astronomical experiments to be made from artificial earth satellites. Included are those experiments which, in the authors' opinion, should be given the highest priority in the immediate future. The experiments in the report are divided into the following sections: the spectrum of the sun in the star ultraviolet; Lyman-alpha spectroheliograms; density of the earth's atmosphere; spectroheliograms in helium lines; profile of Lyman-alpha; the continuous solar energy distribution at wavelengths between 100 and 3000 Å; solar energy distribution in the infrared; direct photoelectric and photographic observations of the zodiacal light; measurements of ultraviolet energy from stars, nebulae, and the sky background; and radio astronomy observations from a satellite. Each of the sections contains a discussion of a broad area of research, including reasons why observations from satellites would be of value. Specific recommendations are given as to the type of instrumentation to be used, the rate of data acquisition, the size and orientation of the satellite orbit, and other pertinent design specifications.

1,276 CONSIDERATIONS OF A HIGH ALTITUDE SPACE VEHICLE (HALL PROJECT)
ES-20515
Smith, S., Dennis, P., and Smith, A.
March 28, 1946
Douglas Aircraft Company, Inc., El Segundo, Calif.

This report summarizes the preliminary available data on a high-altitude space vehicle. Preliminary calculations indicate the feasibility of such a vehicle, the purpose of which is an observation and experimental platform for electronic and meteorologic investigations. The vehicle would orbit at an altitude of 80 miles, remaining for a period of 3 to 30 days.

1,277 **PAPER ON THE DETERMINATION OF THE DENSITY OF THE UPPER REACHES OF THE ATMOSPHERE BY THE SECULAR CHANGES OF THE ELEMENTS OF THE SPUTNIKS' ORBIT (Paper presented at the Rocket and Satellite Symposium during the Fifth Reunion of the Comité Special Année Géophysique Internationale held in Moscow, July 30–August 9, 1958)**
Elyasberg, P. E.
National Academy of Sciences, National Research Council, Washington, D.C.

It is common knowledge that the secular changes of the elements of the Sputniks' orbits are determined, to a considerable extent, by the influence of air drag. In view of this it seems expedient to set the task of determining air density by measuring the elements of the orbit. The solution of this task is of interest from the standpoints of checking the hypothesis on the structure of the upper layers of the atmosphere and of determining initial data for the subsequent accurate computation of the Sputniks' orbits, forecasting their further movement, and determining their life spans. This paper is devoted to the solution of the stated problem from the results of the tests of the first three Soviet artificial earth satellites.

1,278 **OUTSTANDING CONTRIBUTION OF SOVIET SCIENTISTS IN THE INVESTIGATION OF THE COSMOS (OUTER SPACE)**
***Pravda*, March 29, 1959**
Zygielbaum, J. L., translation
April 6, 1959
California Institute of Technology, Pasadena, Jet Propulsion Laboratory

This article praises the Russian scientists who are working on the artificial earth satellites and space probes. No new information is given, but some of the facts obtained from these experiments are briefly mentioned.

1,279 **SPACE VEHICLE TRANSPONDER (PRELIMINARY DESIGN)**
Mathison, R. P.
March 27, 1959
California Institute of Technology, Pasadena, Jet Propulsion Laboratory
Section Report No. 16-64

The purpose of this report is to present the current development ideas for a phase-coherent transponder intended for integration with the world net for space-probe tracking. It is hoped that the report will stimulate thinking and comment on desired characteristics and functions of such a transponder in terms of tracking and communication requirements consistent with the present and near-future state of the art. The development is divided into three phases, each one of which is intended to produce a progressively more sophisticated and reliable transponder. The transponder mechanization is in such form that each succeeding phase builds upon the previous phase.

1,280 ON THE REPRESENTATION OF THE SOLUTIONS OF THE RESTRICTED PROBLEM OF THREE BODIES BY POWER-SERIES
Schulz-Arenstorff, R.
March 30, 1959
Army Ballistic Missile Agency, Redstone Arsenal, Ala.
Report No. DC-TR-1-59

The considered problem consists of the description of the solutions of the equations of motion for a particle with mass zero under the gravitational attraction of two positive masses which revolve in plane circles around their center of gravity. This, for instance, is nearly the situation for a lunar probe flight.

Sundman's theory of the *three body problem* will be transferred to the restricted case, thus yielding power series for the coordinates of the particle and the time, which represent the entire motion. By use of the local existence theorem for differential equations, the solutions, i.e., the coordinates as functions of time, are established in a small complex neighborhood of the initial point zero of the complex time variable. Analytic continuation of the solution along the real time axis will be performed until there is a finite real singularity. By transferring to a proper local uniformizing variable instead of time and change of coordinates by a canonical transformation the solutions can be regularized. After analytic continuation over any finite number of real singularities–if these exist they are seen not to have a finite accumulation point–the solutions will be represented by a new global uniformizing parameter s as independent variable. Then the coordinates and the time are regular (holomorphic) functions of s in a domain of the complex s-plane, which contains the real s-axis, the latter corresponding one-by-one to the real t-axis. Conformal mapping of the domain to the unit circle of a new complex plane shows that the coordinates and the time can be developed into power series which represent the motion for all finite times in parameter form and whose coefficients are functions of the initial values.

1,281 MOTION OF A SPINNING ROCKET CLUSTER
von Roos, O. H., and Holdridge, D. B.
December 31, 1958
California Institute of Technology, Pasadena,
Jet Propulsion Laboratory
Progress Report No. 20-376

The complete equations of motion of a multistage rocket are solved for the period of powered flight. Numerical calculations are discussed using an RTV high-speed cluster as an example, and the results are presented in graphic form. Two assumptions were made: (1) the separation of the stages was considered to be "smooth"; (2) the thrust-vs-time curve was approximated by a rectangle, which amounts to the assumption of a constant mv in the torque equations. The influence of various misalignments is investigated. A review of the results of the calculations in general terms is somewhat difficult owing to the highly nonlinear character of the equations of motion.

1,282 **A WEIGHT COMPARISON OF SEVERAL ATTITUDE CONTROLS FOR SATELLITES**
Adams, J. J., and Chilton, R. G.
February, 1959
National Aeronautics and Space Administration, Washington, D.C.
NASA Memo 12-30-58L

A brief theoretical study has been made for the purpose of estimating and comparing the weights of three different types of controls that can be used to change the attitude of a satellite. The three types of controls are jet reaction, inertia wheel, and a magnetic bar which interacts with the magnetic field of the earth. An idealized task which imposed severe requirements on the angular motion of the satellite was used as the basis for comparison.

The results showed that a control for one axis can be devised whose weight will be less than 1% of the total weight of the satellite. The inertia-wheel system offers weight-saving possibilities if a large number of cycles of operation are required; whereas the jet system would be preferred if a limited number of cycles are required. The magnetic-bar control requires such a large magnet that it is impractical for the example application but might be of value for supplying small trimming moments about certain axes.

1,283 **THE ATMOSPHERE OF VENUS**
Dole, S. H.
October 12, 1956
Rand Corp., Santa Monica, Calif.
P-978

From an empirical relationship between the masses and densities of the terrestrial bodies for which good data are available, it is estimated that the depth of Venus's atmosphere, based on present thoughts as to the evolution of earth's atmosphere, is as follows: about 90% carbon dioxide, about 10% nitrogen, traces of argon, and no water; some free oxygen may also be present. Surface barometric pressure is estimated to be of the order of 10 atmospheres and the mean surface temperature is estimated to be higher than 150°F.

1,284 CORRECTION OF EPOCH ERROR IN CIRCULAR ORBITS. PART I. CORRECTION BY TANGENTIAL TRANSFER
Berman, L. J. (Massachusetts Institute of Technology)
February, 1959
Air Force Office of Scientific Research,
Washington, D.C.,
Mechanics Division
AFOSR Tech. Note 59-62 (ASTIA AD-209,494)

The motion of a body in space can be characterized by six parameters. In this paper, only one of the parameters, the epoch, is considered to be in error, and the other five parameters, covering the size, shape, and orientation of the orbit, are assumed to be correct. It is assumed that the original orbit is circular.

The epoch correction is made by putting the vehicle into a transfer orbit with a period differing from that of the circle and then going back to the original orbit at some subsequent point of intersection. The orbit changes are effected by impulses of thrust. The case of the transfer orbit being tangential to the circle is discussed.

All equations are written in nondimensional terms, each quantity being ratioed to the corresponding quantity for some standard orbit.

1,285 TRACKING OF A MOVING TRANSMITTER BY THE DOPPLER EFFECT
Skinner, T. J.
December, 1958
Air Force Cambridge Research Center, Bedford, Mass.,
Electronics Research Directorate
AFCRC-TR-58-364

This report considers the feasibility of tracking a moving transmitter (in particular, an artificial earth satellite) by measurements of doppler shift only. Although it is shown to be possible to track a transmitter moving on an arbitrary course, unless sufficient prior knowledge of the motion is available the experimental and computational procedures are impractically involved. With this in mind, two restricted types of motion are considered—constant velocity and two-body central field motion. The former is analytically very simple, and the latter is a reasonable approximation of the motion of an artificial satellite.

The constant-velocity case is shown to be a very poor approximation of the motion of an artificial satellite. In spite of this the simple closed-form solutions obtaining by assuming constant velocity are useful in suggesting methods of approaching the more complicated central field motion. Two of these methods are given in this paper. One scheme, which requires measurements at only one receiver while the satellite passes by one, suffers from long computation time. The other scheme uses six receivers spaced around the orbit, but offers accuracies of about 1% with relatively short computer time.

1,286 **PERTURBATIONS OF A TWENTY-FOUR-HOUR SATELLITE ORBIT**
Lautman, D. A.
March, 1959
Avco Manufacturing Corp., Stratford, Conn.,
Avco Research Laboratory
Research Report 43

An investigation has been started to determine the orbit changes of an artificial satellite which is essentially stationary with respect to the surface of the earth. The interest in this problem is based on the 24-hr-communication satellite. The essential results contained in this paper are tabulated as follows:

Launching Precision Requirements: The stationary satellite will have a circular orbit with a radius of 42,164.3 km or 26,200 statute miles, assuming only the central force due to the earth. Orbit perturbations due to the oblateness of the earth, the sun, and the moon would change this radius slightly.

In order for a stationary satellite to keep its position to within 1 deg for a period of 1 year, the following launching requirements are needed. An error in latitude of ½ deg will cause an oscilation of ½-deg amplitude within a 24-hr period. An orbit eccentricity of 0.004 will produce a 1 deg daily oscillation in the equatorial plane about the desired position. An error in orbit radius of 600 ft will produce a drift in the satellite's position in the equatorial plane at the rate of 1 deg per year.

Orbit Perturbations: Major perturbations due to the sun, the moon, and the equatorial bulge have been analyzed. The equatorial bulge will not move the orbit out of the equatorial plane. Perturbations due to the sun and the moon will move the orbit out of the equatorial plane at an initial rate of 1 deg year. Periodic oscillations of the orbit due to the sun and the moon are $\frac{1}{20}$- and $\frac{1}{100}$-deg amplitude, respectively.

It is concluded that the major problem in establishing a stationary satellite will be in the launching. Once established, the satellite will remain within 1 deg of its original position for the first year.

1,287 **ON PRESSURE AND DENSITY OF ATMOSPHERE (Paper presented at the Rocket and Satellite Symposium during the Fifth Reunion of the Comité Special Année Géophysique Internationale held in Moscow, July 30–August 9, 1958)**
Michnevich, V. V.
National Academy of Sciences, National Research Council, Washington, D.C.

In the USSR, studies of the atmosphere up to 80 km are made by means of meteorological rockets and at higher altitudes by geophysical rockets and satellites. Measurements of pressure within the limits of 10^{-5} to 10^{-7} mm Hg are made by special magnetic-ionization manometers, and within the range of 10^{-5} to 10^{-8}

mm Hg by thermo-ionization manometers. The limitations and advantages of these manometers are given. The results of density measurements from rockets and some preliminary data on atmospheric density obtained by the satellite are presented.

1,288 **SURVEY OF RADIATION AROUND THE EARTH TO A RADIAL DISTANCE OF 107,400 KILOMETERS**

Van Allen, J. A., and Frank, L. A.
State University of Iowa, Iowa City,
Department of Physics
SUI-59-2

Descriptions are given of: (1) the equipment used in the detection of the Van Allen Radiation Belt and in the transmission of data from the space probe, (2) the vehicle (Pioneer III) and its trajectory, and (3) the log of flight and telemetry. Observations were obtained on the effective radial extent of the geomagnetic field, the interplanetary value of cosmic ray intensity, and fluctuations in counting rate beyond 10 earth radii.

1,289 **DECELERATION AND HEATING OF A BODY ENTERING A PLANETARY ATMOSPHERE FROM SPACE**

Gazley, C., Jr.
February 18, 1957
Rand Corp., Santa Monica, Calif.
P-955

Solutions to the problem of penetrating a planetary atmosphere from space and effecting a safe landing with instrumented or manned vehicles is a prerequisite to space flight. Deceleration and gasdynamic heating rates must be restrained to tolerable levels to allow survival of the vehicle's payload and structure.

The dynamics and thermodynamics of several types of entry into the atmospheres of Venus, earth, and Mars are considered. Deceleration and heating are most severe for direct entry from a parabolic approach orbit. Appreciable reduction is obtained if the vehicle can be maneuvered into a circular satellite orbit; entry by decay from a circular orbit is more gradual, and both deceleration and heating occur higher in the atmosphere. Further reduction is obtained through the use of a body with gasdynamic lift. In all cases, surface heating rates can be reduced by increasing the drag–mass ratio of the body, or the lift–mass ratio in the case of a lifting body.

Based on current estimates of planetary atmospheres and hypersonic gasdynamics, successful penetration of the atmospheres of Venus, earth, and Mars appears feasible providing a proper planetary approach can be made. Heating and deceleration during entry into the atmospheres of Venus and earth are almost identical. Heating and deceleration are appreciably lower for entry into the Martian atmosphere.

1,290 **RESEARCH IN SPACE SCIENCE**
Jacchia, L. G., Hawkins, G. S., Veis, G., and Whitney, C. A.
December 6, 1958
Smithsonian Institution, Cambridge, Mass.,
Astrophysical Observatory
Special Report No. 19

The following papers are included: *The Earth's Gravitational Potential as Derived from Satellites 1957 Beta One and 1958 Beta Two,* L. G. Jacchia; *A Satellite Meteor-Trap,* G. S. Hawkins; and *A Flashing Satellite for Geodetic Studies,* C. A. Whitney and G. Veis.

1,291 **INSTRUMENTATION PROBLEMS OF MEDIUM SATELLITES**
Stuhlinger, E.
1956
Army Ballistic Missile Agency, Redstone Arsenal,
Huntsville, Ala.
ASTIA AD-112,810

In the present study, the capabilities of satellites for scientific measurements are investigated. A tentative scheme is offered which shows how the planning for satellite instrumentation might be scheduled. A list is given of possible experiments that could be conducted from a satellite vehicle.

1,292 **TENTATIVE EVALUATION OF TRANSMISSION FACTORS FOR SPACE VEHICLE COMMUNICATION**
Kelley, L. C., Perlman, S., Russell, W. J., Jr., and Stuart, W. D.
September, 1958
Army Signal Radio Propagation Agency,
Fort Monmouth, N.J.
Project NR. 664

With the increased use of space vehicles a study of the various propagational and equipment factors affecting space-vehicle communication is needed. This report makes a preliminary evaluation based on theoretical considerations and the limited experimental evidence from the existing satellites, moon-radar experiments, and radio astronomy measurements.

The optimum frequencies for the varied needs of space-vehicle communication can best be determined from estimated system performance. A discussion is given of the noise limitations, equipment limitations, proper choice of earth station locations, and the other factors that affect the signal-to-noise ratio at the receiver. Some of the newer technical developments that increase sensitivity to weak signals are evaluated for their potential increase in distance of communication. Some consideration is given to the effects of the ionosphere, including absorption, angle errors, faraday rotation of polarization, meteor-trail interference, and auroral interference, and to the effects of oxygen, water vapor, and other gases that cause absorption, angular deviation, and noise.

Included is a selection of the better frequencies for line-of-sight and over-the-horizon communication with space vehicles and the frequencies that would be less subject to mutual interference with earth stations for communication between vehicles. A discussion is given of the advantages of elevated locations for communication with space vehicles, including "hovering" vehicles. It is demonstrated that equivalent noise temperature is a more useful measure of signal-to-noise ratio of receiver performance than the standard noise figure definition.

1,293 SPACE HANDBOOK: ASTRONAUTICS AND ITS APPLICATIONS
December 29, 1958
U.S. Congress, 85th, Second Session

An exhaustive report on the technology and applications of space probes and satellite vehicles is presented together with a discussion of general space research. Details are given of space environment, trajectories and orbits, rocket vehicles, propulsion systems, propellants, internal power source, structures and materials, flight path and orientation control, guidance, communication, observation and tracking, atmospheric flight, landing and recovery, environment of manned systems, space stations and extraterrestrial bases, nuclear-weapons' effects in space, cost factors and ground facilities, and current technology programs in the United States. Specific flight possibilities are discussed, and a wide variety of applications for satellite vehicles is outlined. The applications of scientific space exploration are reviewed. Also included is a description of progress in astronautics in other countries.

1,294 STUDIES OF A HIGH ALTITUDE TEST VEHICLE IN A DISSIPATING ELLIPTIC ORBIT
Chien, W. Z.
July 9, 1946
California Institute of Technology, Pasadena,
Jet Propulsion Laboratory
Report No. 8-4

A study is presented of the motion of an unpropelled vehicle projected at a given altitude with a given velocity in a given direction. The elliptic orbital motion in a vacuum and the influence of air resistance are studied in detail. The results of this study are used to calculate the ultimate gain in altitude and the velocity boost required to project a vehicle from a near-circular orbital motion at a lower altitude to another circular orbital motion at a higher altitude by means of an elliptic path.

1,295 **THE INSTRUMENTATION IN EARTH SATELLITE 1958 GAMMA**
Ludwig, G. H.
February, 1959
State University of Iowa, Iowa City, Department of Physics
SUI-59-3

Explorer III contained a cosmic ray experiment designed to give a comprehensive 2-month survey of the spatial distribution of cosmic ray intensity and its temporal variations at altitudes from 185 to 2800 km. The instrumentation included a single Geiger-Mueller counter and a miniature tape recorder. This combination operated well and produced large quantities of data on a previously unknown high-intensity-radiation region.

1,296 **METEOR OBSERVATIONS IN THE ANTARCTIC, BYRD ANTARCTIC EXPEDITION II**
Poulter, T. C.
Stanford Research Institute, Menlo Park, Calif.

The Byrd Antarctic Expedition of 1933-35 made a great number of meteor observations; this report finally releases the data obtained. A description of the equipment, technique, and procedures employed in the work in the antarctic and a very brief summary of some of the statistics and notes on special observations are presented. Also presented are the tabulation of the data as recorded in the antarctic plus two columns of data which were obtained by plotting the recorded data for each meteor against a coordinate system corresponding to the reticle used for the observations. By plotting the data in this manner, the direction that a meteor was traveling was obtained as well as the angular length of its path.

1,297 **EFFECTS OF MAGNUS FORCE ON AN EARTH SATELLITE**
Cohen, C. J., Frick, C. H., and Bressler, B. L.
December, 1958
U.S. Naval Proving Ground, Dahlgren, Va.
Technical Memorandum No. K-22/58

The magnitude of the Magnus force on a spherical satellite and the effect of this force on the orbit of the satellite are examined. The Magnus force was computed under the assumption that the free-stream flow impinges upon the body and becomes attached. It is shown that the Magnus force on a satellite (at a height of 100 miles and spinning at 180 rpm) is negligible when compared to the force of gravity, about 2×10^{-8} times the gravity force. Also, the rate of precession of the plane of the orbit (resulting from the Magnus force's being directed normal to the plane of the orbit) is, in general, trivial when compared to the precession rate resulting from the oblateness of the earth.

1,298 **TECHNICAL PAPERS PRESENTED AT THE ROCKET AND SATELLITE SYMPOSIUM, FIFTH REUNION OF THE COMITE SPECIAL ANNEE GEOPHYSIQUE INTERNATIONALE IN MOSCOW, JULY 30–AUGUST 9, 1958**
Chudakov, A. E., Vernov, S. N., Gorchakov, E. V., Logachev, E. V., and Vakulov, P. V.
National Academy of Sciences, Washington, D.C.
TP-44

Two papers are included in this report: *Photon Study on the Third Sputnik,* A. E. Chudakov, and *Study of Cosmic-Ray Soft Component by the Third Soviet Earth Satellite,* S. N. Vernon, A. E. Chudakov, E. V. Gorchakov, Ju. I. Logachev, and P. V. Vakulov. Both papers describe the scintillation counter used for photon reading which was placed on the third Sputnik and present data obtained from the instrument.

1,299 **THE SECOND SOVIET ARTIFICIAL EARTH SATELLITE**
***Pravda,* 1957**
Palmer, J. W., translation
March, 1958
Royal Aircraft Establishment, Farnborough, Great Britain
Translation 722

This report contains the following articles published between October 10 and November 18, 1957: *Tass Statement; The Second Soviet Artificial Earth Satellite; Observation of Artificial Earth Satellites; The Upper Atmosphere and its Investigation with the Aid of an Artificial Earth Satellite,* V. I. Krasovskii; *Investigation of the Magnetic Field of the Earth with the Aid of Satellites,* S. Dolginov and N. Pushkov; *Towards the Conquest of Cosmic Space,* O. Gorlov and V. Yakolev; *Penetration into the Secrets of the Universe,* S. N. Vernov; *Conversation Between Two Satellites,* Quo Mo Sho; and *Around the Earth and Around the Satellites,* G. Rassadin.

1,300 **IONOSPHERIC ELECTRON CONTENT DEDUCED FROM THE FARADAY FADING OF SIGNALS FROM ARTIFICIAL EARTH SATELLITES**
Blackband, W. T., Burgess, B., Jones, I. L., and Lawson, G. J.
December 19, 1958
Royal Aircraft Establishment,
Farnborough, Great Britain
Radio/OC49/WTB

From a study of the fading of radio signals received from earth satellites it is shown that it is possible to deduce the electron content from the sample of the ionosphere between the satellite and the receiving station for a large section of the observed trajectory. This gives a sample across the sky, and can give information about the region above the F_2 maximum which is unexplorable by the methods of ionospheric sounding.

Results of observations from several different stations are in good agreement and are also in agreement with estimates made by an independent method. It is concluded that the method of analysis is reliable and can be used for further observations. The method provides a way of determining horizontal variations in the ionosphere both above and below the maximum of ionization and has advantages in that the experimental technique and apparatus used are simple, while timing accuracy of 1 or 2 sec is sufficient.

1,301 **ON THE MOTION OF A SATELLITE OF AN OBLATE PLANET**
Garfinkel, B.
July, 1957
Aberdeen Proving Ground, Md.,
Ballistic Research Laboratories
Report No. 1018

An approximate orbit is here defined by the potential function

$$V_0 = -\mu/r + 3k\,(\sin^2\theta - \cos^2 i)/a(1 - e^2)\,r^2$$

with

$$\mu = 1 - 3k\,[1 - 3/2\sin^2 i]/a^2\,(1 - e^2)^{3/2}$$

where r is the radius vector, θ is the complement of the polar angle, a, e, and i are constants analogous to the usual elliptic elements, and k is the equatorial bulge constant. The choice of V_0 leads to a simple closed solution, free from all secular perturbations. The longitude is affected by a long-period perturbation of amplitude

$$3e^2\sqrt{l - e^2}\,\sin^2 i/16[l - 5/4\sin^2 i]$$

which must be applied as an orbit correction if the value of the inclination is in the neighborhood of the resonance value 63°.4. The remaining perturbations in the coordinates are of short period and of small amplitude, involving k as a factor. In many practical applications all perturbations are so negligible that orbit may be sufficiently accurate without any corrections.

1,302 MAN IN SPACE
Pickering, W. H. (Jet Propulsion Laboratory)
April 29, 1958
Data Publications, Washington, D.C.
2 ASTRO-7

A discussion is given considering the question: For what type of space mission is a human passenger essential? It is shown that human passengers are not necessary for satellite missions or for space or lunar probes, but that in order to evaluate new situations and select proper courses of action there is a need for the human passenger in the actual exploration of the moon or planets.

1,303 PRELIMINARY REPORT ON LAUNCHING IN THE USSR OF THE FIRST AND SECOND ARTIFICIAL EARTH SATELLITES
February 5, 1958
Special Committee for the IGY, France

Trajectories, instrumentation, radio and visual observations, and radio transmission of Sputniks I and II are described. Solar short-wave radiation and cosmic rays were investigated. Information concerning biological phenomena under conditions of cosmic flight was obtained from Sputnik II, which contained special equipment for recording physiological activities of its dog passenger.

1,304 A SUMMARY OF PERFORMANCE STUDIES FOR A HIGH ALTITUDE ORBITING MISSILE
Stewart, H. J.
July 10, 1946
California Institute of Technology, Pasadena,
Jet Propulsion Laboratory
Report No. 8-5

A series of performance studies for a high-altitude orbiting missile has been carried out. This report contains a summary of the results of these studies. The orbiting missile to be considered is a single-stage liquid-propellant rocket missile. The propellants are liquid oxygen and liquid hydrogen. The specific impulse is estimated to be 330 sec at sea level and 441 sec at very high altitudes.

1,305 **SCIENTIFIC REPORT NO. 1 ON RADIO TRACKING OF EARTH SATELLITES**
June 30, 1958
Pickard & Burns, Inc.
Needham, Mass.
AFCRC-TN-58-353 (ASTIA AD-160,846)

Radio techniques for tracking earth satellites are presented. Concentration is on passive techniques. Radar techniques and those involving infrared detection are excluded. The study includes doppler and interferometer techniques. The laws of planetary motion as applied to earth satellites are summarized, as is the application of the doppler effect to satellite tracking.

Graphical techniques are developed for accurate estimates of the time of nearest pass T_0. While slant range or miss distance r_0 can be estimated from the maximum slope of the curve of doppler frequency vs time at T_0, the estimate is also subject to an estimate of the satellite velocity. A method is given for improved accuracy which allows calculation of r_0 and the relative velocity to an earth-borne observer V_R. Thus, from one pass, doppler measurements from one station yield values of T_0, r_0, and V_R.

Instrumentation schemes for doppler tracking are given. Consideration is given to real and nonreal time data processing. Various schemes of single-station data recording, reduction, and analysis were tried on the several existing satellites, and the results are given.

1,306 **BIBLIOGRAPHY FOR THE INTERNATIONAL GEOPHYSICAL YEAR**
July 1, 1957
National Science Foundation, Washington, D.C.
NSF-57-25

Most of the articles presented herein are of a nontechnical nature. The bibliography has been classified according to the technical fields and regional subdivisions of the IGY program. The organization and operation of the IGY are described and the names of the members of the CSAGI as well as of the members of the U.S. National Committee for the IGY and its technical panels are provided.

1,307 **AVAILABILITY OF UPPER ATMOSPHERIC AND OTHER SELECTED DATA FROM THE IGY**
Greenfield, S. M.
January 7, 1959
Rand Corp., Santa Monica, Calif.
RM-2309-ARPA

Basic understanding of the physics of the upper atmosphere has been hampered by a lack of sufficient data on the various complex phenomena of that region. During the IGY the US spent several hundred million dollars as part of the international effort to collect geophysical data. Much of this was spent specifically for the acquisition of data on the upper atmosphere.

This paper describes the US IGY data archives pertaining to the geophysics of the upper atmosphere. It then reviews the general state of knowledge and the major lines of investigation of the US IGY programs in the interrelated fields of the ionosphere, aurora, cosmic rays, solar activity, and geomagnetism. The program for using rockets and satellites as scientific tools in these IGY studies is also discussed.

Thorough analysis of the IGY data is necessary in order to gain better understanding of the geophysical problems investigated—in short, to realize on the investment in the IGY program. Except for one modest study, American workers are not carrying out extensive analyses of the accumulated IGY data. However, Russian and other foreign workers are performing extensive world-wide analyses of the data contributed by all nations, including the US.

1,308 THE BI-ELLIPTICAL TRANSFER BETWEEN CIRCULAR COPLANAR ORBITS
Hoelker, R. F., and Silber, R.
January 6, 1959
Army Ballistic Missile Agency, Redstone Arsenal, Ala.
DA-TM-2-59

This paper investigates the area of relative altitudes of coplanar circular orbits about the earth for which a bi-elliptical transfer is more economical than the classical Hohmann transfer. It is found that for transfers between orbits separated by radii ratios larger than 15.582, the Hohmann transfer is less economic than a bi-elliptical transfer with an intermediate point of altitude larger than that of the larger terminal orbit. The implications of these findings are indicated.

1,309 PROBLEMS OF HYPERSONIC FLIGHT AT THE RE-ENTRY OF SATELLITE VEHICLES (Paper Presented at the IX Annual Congress of the International Astronautical Federation in Amsterdam, August 25–30, 1958)
Hermann, R.
November, 1958
University of Minnesota, Minneapolis,
Rosemont Aeronautical Laboratories
Research Report No. 153

Flow problems of hypersonic flight at the re-entry of slender or blunt satellite vehicles have been examined using the presentation of flow regimes in the Mach number vs Reynolds number flow diagram. The border lines of continuum flow have been re-evaluated first for slender bodies, i.e., flow along flat plates. Emphasis is placed on the existence of a compressible boundary layer and its growth with Mach number as well as on the conditions for the free path length at the body wall for various cooling conditions.

Some re-entry trajectories for slender bodies and blunt bodies are investigated. The so-called corridor for permanent flight as well as two typical hypersonic glide vehicle paths are transformed into the Mach number vs Reynolds number flow diagram. The same is done for three typical spherical, drag-retarded bodies with ballistic drag parameters varying from 0.01 to approximately 10 ft^2/lb. For both slender bodies and blunt bodies, the re-entry trajectories are found to be located completely within the continuum flow regime and away from distinct slip effects. This has a direct bearing on the calculation of the critical points of maximum deceleration or maximum skin temperature of the blunt bodies, both problems of major concern.

The flow regimes of research facilities, such as hypersonic wind tunnels, can also be mapped with advantage into the Mach number vs Reynolds number diagram. Preliminary results obtained in the hypersonic wind tunnel of the University of Minnesota are presented which relate to shock shape and detachment distance from the stagnation point at $M = 7.4$ and a stagnation temperature of 1900°R. They are compared with the values given by other experiments and various analyses. The necessity for further experimental investigation is evident.

1,310 THE SOVIET COSMIC ROCKET
Pravda
Zygielbaum, J. L., translation
January 12, 1959
California Institute of Technology, Pasadena,
Jet Propulsion Laboratory

Information on the size, weight, construction, instrumentation, launching, etc., of the first Soviet cosmic rocket is given. Photographs and drawings from *Pravda* are included.

1,311 PRELIMINARY ANALYSIS OF A SATELLITE RECOVERY SYSTEM
Frick, R. A.
September 19, 1958
Rand Corp., Santa Monica, Calif.
RM-2264 (ASTIA AD-209,777)

This report presents a preliminary analysis of the capabilities of a satellite recovery system. In the discussion of the problem it is assumed that at some point of a satellite orbit a velocity impulse is applied to the vehicle which results in impact on the earth. The analysis considers the problem of determining the magnitude and direction of the velocity impulse required to produce impact at a specified range from the point of application of the impulse. In addition, the dispersion in range and deflection about the desired impact point is evaluated in terms of the capabilities of the vehicle propulsion and attitude-control system as well as the satellite tracking system.

As an interesting byproduct of this study, a velocity diagram was developed which provides a convenient tool for determining the subsequent characteristics of a trajectory as a function of the velocity and path direction corresponding to a given initial position. This diagram enables one to determine whether the resulting path escapes the earth's field, continues on a satellite orbit, or impacts on the earth. In addition, it determines the range to impact (if any) as well as the shape and orientation of the satellite orbits.

As a result of this study, the magnitude and direction of the change in velocity needed to produce impact have been so optimized as to require a minimum impulse and at the same time to give a minimum value of the dispersion.

1,312 **THE MEASUREMENT OF INTEGRATED EXTRATERRESTRIAL RADIATION BY MEANS OF A SATELLITE-BORNE PHOTOMETER**
Butler, C. T., and Baum, W. A.
February 11, 1959
California Institute of Technology, Pasadena,
Jet Propulsion Laboratory
Publication No. 151

This publication suggests the use of an earth satellite to measure the integrated light arriving from different parts of the extraterrestrial sky. The mechanical portion of this apparatus consists of a rotatable mirror, a lens, and a set of color filters. The electronic portion contains a multiplier phototube, a logarithmic amplifier, various telemetering circuits, and a safety device. Light of various wavelengths and from various directions is viewed in sequence by the multiplier phototube. The data collected in this experiment may facilitate the distinction between cosmological models.

Prototypes of the photometer have been produced and are described. Data transmission, recovery, and interpretation are discussed.

1,313 **EXPLORER IV 1958 EPSILON ORBITAL DATA SERIES, ISSUE 5**
Lynn, J. C. and Hurst, P. O.
November 15, 1958
Army Ballistic Missile Agency, Redstone Arsenal, Ala.

Tables of data obtained by fitting a third-degree least squares polynomial to the doppler shift frequencies received by tracking stations are presented. An explanation of the method used in recording this data is given.

1,314 **ON POSSIBILITY OF MEDIUM DENSITY MEASUREMENTS WITH A SATELLITE (Paper presented at the Rocket and Satellite Symposium during the Fifth Reunion of the Comité Special Année Géophysique Internationale held in Moscow, July 30–August 9, 1958)**

Mirtov, B. A.
National Academy of Sciences, National Research Council, Washington, D. C.

The purpose of this work is to evaluate the trajectory-distorting factors caused by the flight of the satellite itself. In a rarefied gas medium a satellite produces molecular fluxes which move together with it and with very high velocities relative to the molecules of the surrounding medium. A mathematical analysis of the results of this phenomena is presented.

1,315 **METEOROLOGICAL ROCKET RESEARCH OF STRATOSPHERE (Paper presented at the Rocket and Satellite Symposium during the Fifth Reunion of the Comité Special Année Géophysique Internationale held in Moscow, July 30–August 9, 1958)**

Shvidkovsky, E. G.
National Academy of Sciences, National Research Council, Washington, D. C.

Russian scientists have carried out a series of experiments to determine the thermodynamic properties of the stratosphere. Resistance thermometers and manometers were mounted in the noses of sounding rockets. The data tabulated from these instruments are presented.

1,316 **ROCKET AND SATELLITE INVESTIGATION OF METEORS (Paper presented at the Rocket and Satellite Symposium during the Fifth Reunion of the Comité Special Année Géophysique Internationale held in Moscow, July 30–August 9, 1958)**

Nazarova, I. N.
National Academy of Sciences, National Research Council, Washington, D. C.

To record the number as well as the "reactive" momentum of meteor particles hitting the surface of rockets and satellite vehicles, a ballistic piezoelectric pickup and an amplifier-converter are used. Results of the first experiments include recorded particle energies of the order of 10^4 erg.

1,317 **A DISCOVERY OF CORPUSCULE FLUXES BY MEANS OF THE THIRD SPUTNIK (Paper presented at the Rocket and Satellite Symposium during the Fifth Reunion of the Comité Special Année Géophysique Internationale held in Moscow, July 30–August 9, 1958)**
Krassovsky, V. I., Kushnir, Y. M., Bordovsky, G. A., Zakharov, G. F., and Svetlitsky, E. M.
National Academy of Sciences, National Research Council, Washington, D. C.

The third Soviet Sputnik was equipped with two indicators having fluorescent screens covered with aluminum foils of different thickness and photoelectric multipliers which registered the radiation from the fluorescent screens. The signals registered varied greatly. Intensity was the strongest at apogee and in the polar regions. The corpuscules registered are electrons of 10^4 ev.

1,318 **OPTICAL TRACKING OF SATELLITES (Paper presented at the Rocket and Satellite Symposium during the Fifth Reunion of the Comité Special Année Géophysique Internationale held in Moscow, July 30–August 9, 1958)**
Shklovsky, I. S.
National Academy of Sciences, National Research Council, Washington, D. C.

The author feels that under the proper conditions optical tracking of earth satellites can be much more productive scientifically than radio or radar methods. A camera method of measuring satellite coordinates to an accuracy of 5 sec is presented.

1,319 **ON THE ASTRONOMICAL OBSERVATION OF ARTIFICIAL EARTH SATELLITES (Paper presented at the Rocket and Satellite Symposium during the Fifth Reunion of the Comité Special Année Géophysique Internationale held in Moscow, July 30–August 9, 1958)**
Masevich, A. G.
National Academy of Sciences, National Research Council, Washington, D. C.

This paper briefly discusses visual and photographic methods of observing artificial satellites. The problems and solutions to problems encountered in each are mentioned. Some charts and photographs are presented.

1,320 **RADIO AMATEUR OBSERVATIONS IN THE U.S.S.R. ON THE SIGNALS OF SOVIET ARTIFICIAL EARTH SATELLITES (Paper presented at the Rocket and Satellite Symposium during the Fifth Reunion of the Comité Special Année Géophysique Internationale held in Moscow, July 30–August 9, 1958)**
Shakhovskoy, A. M.
National Academy of Sciences, National Research Council, Washington, D. C.

Russian amateur radio enthusiasts were encouraged to participate in satellite tracking programs. The resulting data are still being analyzed. More accuracy of time reference is required if these observations are to be very helpful. However, amateur magnetic recordings have helped to define the parameters of the satellite's rotation.

1,321 **EXPLORATION OF THE IONOSPHERE BY SOVIET SCIENTISTS WITH THE HELP OF ROCKETS AND SPUTNIKS (Paper presented at the Rocket and Satellite Symposium during the Fifth Reunion of the Comité Special Année Géophysique Internationale held in Moscow, July 30–August 9, 1958)**
Krassovsky, V. I.
National Academy of Sciences, National Research Council, Washington, D. C.

The importance of thoroughly exploring and analyzing the ionosphere is discussed in detail. Various methods of carrying out this investigation are presented and results of preliminary efforts are given.

1,322 **MEASUREMENTS OF INTENSITY OF MAGNETIC FIELD WITH THE THIRD SOVIET ARTIFICIAL EARTH SATELLITE (Paper presented at the Rocket and Satellite Symposium during the Fifth Reunion of the Comité Special Géophysique Internationale held in Moscow, July 30–August 9, 1958)**
Dolginov, S. Sh., and Pushkov, N. V.
National Academy of Sciences, National Research Council, Washington, D. C.

The third Soviet artificial satellite contained instruments for measuring the earth's magnetic field. Brief descriptions of these instruments' capabilities are given. However, no definite data are included.

1,323 **INVESTIGATION OF THE ION COMPOSITION OF THE EARTH'S ATMOSPHERE WITH ROCKETS AND SATELLITES (Paper presented at the Rocket and Satellite Symposium during the Fifth Reunion of the Comité Special Année Geophysique International held in Moscow, July 30–August 9, 1958)**
Istomin, V. G.
National Academy of Sciences, National Research Council, Washington, D. C.

A detailed description is given of a radio-frequency mass spectrometer used to investigate the ion composition of earth's atmosphere. This mass spectrometer was installed in Sputnik III, and data obtained from some of the first spirals are given.

1,324 **RADIOWAVE PROPAGATION IN THE IONOSPHERE AND STRUCTURE OF THE F_2 LAYER (Paper presented at the Rocket and Satellite Symposium during the Fifth Reunion of the Comité Special Année Géophysique Internationale held in Moscow, July 30–August 9, 1958)**
Kazantsev, A. N.
National Academy of Sciences, National Research Council, Washington, D. C.

In this paper one of the methods used in processing the results of radio observations of the Soviet artificial earth satellites is examined. This method consisted of the determination of coefficients of radiowave absorption from data of electric field strength measurements conducted by comparator stations. Results obtained by this method are described.

1,325 **DETERMINATION OF THE ELEMENTS OF THE ORBIT OF A SATELLITE USING DOPPLER EFFECT (Paper presented at the Rocket and Satellite Symposium during the Fifth Reunion of the Comité Special Année Géophysique Internationale held in Moscow, July 30–August 9, 1958)**
Kotelnikov, V. A.
National Academy of Sciences, National Research Council, Washington, D. C.

This paper describes a method of using the doppler effect to determine a satellite's orbit. The theory was reasonable but ionospheric distortion reduced the accuracy of the calculations.

1,326 **BIOLOGICAL EXPERIMENTS ON ROCKETS AND ARTIFICIAL EARTH SATELLITES (Paper presented at the Rocket and Satellite Symposium during the Fifth Reunion of the Comité Special Année Géophysique Internationale held in Moscow, July 30–August 9, 1958)**

Yasdovskiy, Y. I.
National Academy of Sciences, National Research Council, Washington, D. C.

The safety of living organisms during rocket flights can be guaranteed only under conditions which protect the organism from the action of a whole complex of unfavorable external factors: high degrees of rarefaction of the air, the absence of molecular oxygen, cosmic rays, ultraviolet radiation, meteors, weightlessness, etc. This paper discusses the programs conducted by the Russians to (1) select the most suitable biological specimen for conducting the experiments (2) develop methods of investigating the physiological functions of an animal suitable for use under the conditions of flight on a rocket, (3) determine the possibility of guaranteeing the conditions necessary for the animal to live with the aid of a small, regenerating, hermetically sealed cabin during rocket flights to an altitude of 100 km, and (4) determine the possibility of utilizing an ejectible cabin to recover animals and apparatus from high altitudes. A good description is given of the Laika experiment.

1,327 **HEAVY NUCLEI IN PRIMARY COSMIC RADIATION (Paper presented at the Rocket and Satellite Symposium during the Fifth Reunion of the Comité Special Année Géophysique Internationale held in Moscow, July 30–August 9, 1958)**

Kurnosova, L. V., Razorenov, L. A., and Fradkin, M. I.
National Academy of Sciences, National Research Council, Washington, D. C.

A device for measuring the number of heavy nuclei in primary cosmic ray flux was installed on the third Soviet artificial satellite. This instrument is based on the Vavilov-Cherenkov effect. The first threshold of device operation was tuned on $Z > 15$–16, and the second was tuned on $Z > 30$–32.

The results were obtained on the basis of preliminary treatment of data on device performance for 10 days. The number of nuclei with $Z > 16$ was estimated during various time intervals. The average number of nuclei with $Z > 16$ amounted to 1.2 ± 0.1 per minute. Only one level transition of the output voltage, which corresponds to recording of nuclei with $Z > 30$, was registered.

1.328 **SOLAR BATTERIES (Paper presented at the Rocket and Satellite Symposium during the Fifth Reunion of the Comité Special Année Géophysique Internationale held in Moscow, July 30–August 9, 1958)**
Vavilova, V. S., and Landsman, A. P.
National Academy of Sciences, National Research Council, Washington, D. C.

Data on the operation of solar batteries in Sputnik III are cited. Factors affecting reliability and efficiency of solar batteries are discussed briefly.

1,329 **CONCERNING THE DYNAMIC EFFECTS ON THE MOTION OF AN ARTIFICIAL EARTH SATELLITE (Paper presented at the Rocket and Satellite Symposium during the Fifth Reunion of the Comité Special Année Géophysique Internationale held in Moscow, July 30–August 9, 1958)**
Sedov, L. I.
National Academy of Sciences, National Research Council, Washington, D. C.

Data concerning the law of motion of a satellite in orbit are necessary for coordinating scientific measurements to points in space, forecasting satellite position, planning the operation of scientific equipment, determining the lifetime of the satellite, and solving certain geophysical problems (revealing and accurately defining anomalies in the earth's gravitational field, determining density distribution in the atmosphere, etc.) The choice of equations and the reasons for the use of various constants are given.

ASTRONAUTICS INFORMATION ABSTRACTS, PART C

May 1–August 31, 1959

1,330 THE DISTRIBUTION OF 5577 NIGHTGLOW INTENSITIES
McCaulley, J. W., Marovich, E., and Roach, F. E.
October 8, 1958
National Bureau of Standards, Boulder Laboratories, Boulder, Colo.
NBS Report 6012

In general, the zenith intensities of 5577 nightglow cover a tenfold range from about 100 to 1000 Rayleighs. Occasionally, however, zenith intensities higher than 1000 Rayleighs are recorded (the visual threshold for extended objects in the green and the brightness of an aurora I). During the IGY, the various airglow observers have agreed to interchange their results in the form of hourly zenith intensities. Approximately one-half of the total IGY data from 16 stations is now available, and the distributions of 5577 zenith intensities have been determined for this body of data.

1,331 RESEARCH IN SPACE SCIENCE. PART I: THE EARTH'S GRAVITATIONAL POTENTIAL DERIVED FROM THE MOTION OF A SATELLITE 1958 BETA TWO. PART II: ON THE EFFECTS OF THE SUN AND THE MOON UPON THE MOTION OF A CLOSE EARTH SATELLITE
Kozai, Y.
March 20, 1959
Smithsonian Institution, Cambridge, Mass., Astrophysical Observatory,
Special Report 22

It was reported that the long-period (80-day) variations in the eccentricity of the orbit of Satellite 1958 Beta Two (Vanguard) can be explained by a north–

south asymmetry in the gravitational potential of the earth. That is, the axial symmetry of the field is retained, but the third harmonic in latitude is added. The first part of this paper is a mathematical analysis of this problem.

The second part of this paper presents a mathematical analysis of the effects of solar and lunar perturbations of a close earth satellite whose radius is very small compared with that of the moon. Since the disturbing functions of the sun and the moon both have similar forms, only the method of deriving the perturbation for the moon is described.

1,332 LUNAR PROBE TRAJECTORIES; CHARACTERISTICS AND TOLERANCES FOR COPLANAR FLIGHTS
Hoelker, R. F., and Braud, N. J.
February 17, 1959
Army Ballistic Missile Agency, Redstone Arsenal, Ala.
DA-TM-26-59

The objectives of this report are (1) the analysis of parameter combinations of initial conditions that result in ballistic probe flights impacting perpendicularly on the moon, (2) the description of associated flight parameters such as flight time and impact velocity, (3) the study of the effect of accuracy requirements on the initial conditions for achieving impact in general, and (4) a discussion of certain combinations of initial conditions that are least critical for velocity errors.

The results achieved previously by means of the two-body approach are extended in this Report to the three-body problem. The three-body problem is restricted by assuming negligible mass of the probe and the orbits of the two terminal bodies moving circularly in a common plane about their mass center.

The probe flight is restricted to this plane, except for the cases in which the effects of errors in injection in azimuth are studied.

1,333 PROJECT MERCURY BACKGROUND MATERIAL
March 23, 1959
National Aeronautics and Space Administration
Langley Aeronautical Laboratory, Langley Field, Va.
Technical Report No. 3

The history of Project Mercury is described and the organization within NASA responsible for research and development of the project is presented in diagram form. The objectives of Project Mercury are to put a manned vehicle into orbital flight and to effect a safe recovery of the man and vehicle from orbit. Basic principles and methods are presented, and the general arrangement and operation of the orbital system are described and illustrated.

1,334 **THE EFFECT OF THE EARTH'S ATMOSPHERIC ROTATION ON THE ORBITAL INCLINATION OF A NEAR EARTH SATELLITE**
Plimmer, R. N. A.
January, 1959
Royal Aircraft Establishment, Great Britain
Technical Note G. W. 504

A theoretical formula has been derived which expresses the change in orbital inclination of a near earth satellite due to the rotation of the earth's atmosphere. Comparison of the change in orbital inclination as calculated from the theoretical expressions with those evaluated from cinetheodolite observations for Sputnik II (1957 Beta) shows reasonably good agreement. The corresponding comparison for the rocket of Sputnik III (1958 Delta One) suggests that the theoretical curve should be slightly steeper, although the discrepancy could well be due to the inaccuracy of the observations.

1,335 **BALLISTICS OF THE EXPLORER**
Froehlich, J. E., and Hibbs, A. R.
August 13, 1958
Jet Propulsion Laboratory, California Institute of Technology, Pasadena
Report 20-118

A discussion is presented of the trajectories used in launching Explorers I and III. Particular attention is given to the problems involved in the optimization of these trajectories with regard to payload weight and lifetime.

The lifetimes of the Explorer experiments are directly proportional to the weight of the batteries that power the radio transmitters. On the other hand, the lifetimes of the orbits are functions of the launching altitude and speed, and therefore depend inversely on the total battery weight. Another important consideration in selecting lifetimes is the fact that there are certain inaccuracies inherent in the launching of these satellites.

Sources of trajectory errors are derived and discussed. Consideration is given to the choice of both thrust and spin rate for the high-speed stages. A probabilistic analysis of trajectory errors is then used to determine optimum launching conditions, and the criteria used to establish these conditions are discussed at length. Finally, the results of the two satellite firings are reviewed and compared with predicted orbits.

1,336 A SURVEY OF SPACE-PROBE INSTRUMENTATION FOR USE IN THE STUDY OF INTERPLANETARY PLASMAS
Neugebauer, M.
April 27, 1959
Jet Propulsion Laboratory, California Institute of Technology, Pasadena
Section Report 22-3

The solar corpuscular radiation has many important geophysical and astrophysical implications. Its properties should be studied by space probes to provide a clear idea of how the interplanetary plasma varies over the solar system during times as great as the 11-year solar cycle.

The first generation of instruments sent into space cannot hope to determine the detailed properties of the solar plasma. In fact, the several predictions of the flux and energy ranges of this radiation are so varied, and often contradictory, that the first solar-plasma instrument to be sent into space will probably be that one which has the highest probability of detecting anything at all.

The predicted nature of the solar corpuscular radiation, as determined by indirect methods from the earth, is briefly reviewed and summarized herein. A general survey is given of the gross features of several instruments which might prove useful for the direct investigation of the interplanetary plasma. The flux and energy sensitivities of each instrument are then compared to the predicted flux and energy range of the plasma in an effort to decide which instrument is likely to give the most information.

1,337 WHAT OBSERVATIONS OF THE MOON CAN GIVE TO GEODESY (Continuation)
Mikhajlov, A. A.
Geodesiya i Kartografiya, Moscow
November, 1957
U. S. Joint Publications Research Service, Washington 25, D. C.
November 12, 1958
JPRS/DC-L-1099

Observations of eclipses of stars by the moon and solar eclipses have been used to calculate the geocentric coordinates of the points of observation on the earth. The corrected lunar coordinates will serve to determine ephemeral time. Lunar coordinates can also be found by the photographic method which calculates the equatorial coordinates of the moon with respect to the surrounding adjacent stars. The Pulkovskij and Washington methods for photographing the moon are described, and methods for measuring the photographs of the moon and stars are given.

1,338 OPENING REMARKS OF BRIGADIER GENERAL HOLLINGSWORTH F. GREGORY, COMMANDER, AIR FORCE OFFICE OF SCIENTIFIC RESEARCH, AT THE SECOND ANNUAL AFOSR ASTRONAUTICS SYMPOSIUM IN DENVER, COLORADO, 28 APRIL 1958
Data Publications, Washington 6, D. C.
2 ASTRO-1

1,339 NEARLY CIRCULAR TRANSFER TRAJECTORIES FOR DESCENDING SATELLITES
Low, G. M.
1959
National Aeronautics and Space Administration
Lewis Research Center, Cleveland, Ohio
Report 3

Simplified expressions describing the transfer from a satellite orbit to the point of atmospheric entry are derived. The expressions are limited to altitude changes that are small compared with the earth's radius and to velocity changes that are small compared with satellite velocity. The expressions are further restricted to motion about a spherical, nonrotating earth.

The transfer trajectory resulting from the application of thrust in any direction at any point in an elliptic orbit is considered. Expressions for the errors in distance (miss distance) and entry angle due to an initial misalignment and magnitude error of the deflecting thrust are presented. The guidance and accuracy requirements necessary to establish a circular orbit are discussed together with orbit corrections.

1,340 A 20,000-KILOWATT NUCLEAR TURBOELECTRIC POWER SUPPLY
English, R. E., Slone, H. O., Bernatowicz, D. T., Davison, E. H., and Lieblein, S.
March, 1959
National Aeronautics and Space Administration,
Lewis Research Center, Cleveland, Ohio
Memorandum 2-20-59E

Conceptual design of a nuclear turboelectric powerplant producing 20,000 kw of power suitable for manned space vehicles is presented. The study indicates that the radiator necessary for rejecting cycle waste heat is the dominant weight, and emphasis is placed on the selection of cycle operating conditions in order to reduce this weight. A thermodynamic cycle using sodium vapor as the working fluid and operating at a turbine-inlet temperature of 2500°R was selected.

The total powerplant weight was calculated to be approximately 6 lb/kw. The radiator contributes approximately 2.1 lb/kw to the total weight, and the reactor and reactor shield contribute approximately 0.24 and 1.2 lb/kw, respectively. The generator, turbine, and piping add significantly to the total weight (between 0.5 and 0.6 lb/kw), but the heat exchanger, pumps, etc., are less important.

Several important research areas associated with the development of a reliable nuclear turboelectric powerplant of the type analyzed are discussed.

1,341 **EXPERIMENTAL STUDIES OF PLASMA JET PROPULSION**
Howard, D. F.
April 28, 1958
Giannini Research Laboratory
Data Publications, Washington 6, D. C.
2 ASTRO-3

A plasma jet of white-hot (between 15,000 and 30,000°F) dissociated argon is produced by a cylindrical chamber with a cylindrical electrode at the back and a circular electrode at the front. The working gas entering near the back and exhausting through the hole in the front electrode is heated and ionized while passing through an arc maintained between the electrodes. The exit velocity of 4500 ft/sec imposes an appreciable thrust. The nature and magnitude of the energy recoverable from the plasma jet propulsor are considered in the experiments. The propulsion system may be of interest in astronautics.

1,342 **SATELLITES FOR WORLD COMMUNICATION**
(Hearings before the Committee on Science and Astronautics—House of Representatives)
U. S. Congress
86th, First Session
March 3 and 4, 1959
United States Government Printing Office
Washington, D. C.

The use of satellite vehicles as a means of worldwide communication is fully discussed. Their use as transmission or relay stations for telephone, television, and radio communication would greatly improve the existing communication set-ups. The advantages of using these orbital relay or communication stations are outlined, and the details of regulating their use, such as frequency band allocations, are made.

1,343 PHOTOGRAMMETRIC FLARE TRIANGULATION
Brown, D. C.
December 2, 1958
Air Force Missile Test Center, Patrick AFB, Florida
AFMTC-TR-59-3 (ASTIA AD-211, 431)

The highly successful application of ballistic cameras of high precision in missile testing at the Atlantic Missile Range over the last three years has suggested the feasibility of an entirely new approach to the problem of geodetic flare triangulation. The mathematics and the philosophy of the approach are outlined. It is pointed out that by employing established procedures utilizing standard pyrotechnic flares ejected from rockets or satellites as relative control points, together with photographed background stars as absolute control points, all the difficulties and shortcomings associated with conventional geodetic flare triangulation can be circumvented. In particular, atmospheric refraction, deflections of the vertical, and synchronization present no problems. Accordingly, three-dimensional, rather than two-dimensional (azimuth only), determination of position is possible. This permits the direct determination of the heights of the unknown stations in a photogrammetric net to adjust the locations of the "known" stations in a photogrammetric net to a degree consistent with their postulated accuracies. Hence, the method is particularly well suited to the problem of improving existing geodetic nets.

The results of two numerical studies are presented. One, based upon actual data obtained from a missile test, establishes the practicability of the proposed solution. The other, a theoretical study involving Hawaii and Midway as unknown stations and five locations in North America as known stations, establishes the potentialities of the proposed approach. It is demonstrated that observations of a total of 27 flares ejected during a single pass of a satellite at an altitude of 1000 miles could lead to position determinations of Hawaii and Midway accurate to better than 20 ft in each coordinate, provided that cameras of 600-mm focal length were employed at all stations. The distance between the islands would be estimated to 1 part in 400,000. In view of this, it is suggested that the utilization of satellites as nothing more than vehicles permitting photogrammetric flare triangulation would solve basic geodetic problems more readily, and would involve fewer observations and yield higher accuracy than alternative procedures which depend fundamentally upon the kinematics of satellites.

1,344 THE TWO-DIMENSIONAL LIBRATIONS OF A DUMBBELL-SHAPED SATELLITE IN A UNIFORM GRAVITATIONAL FIELD
Stocker, T. A. J., and Vachino, R. F.
March, 1958
Air Force Institute of Technology,
Wright-Patterson AFB, Ohio
(ASTIA AD-161, 832)

Many proposed applications of artificial earth satellites require that the satellites be oriented relative to the direction of the earth, the local vertical. It has been proposed that a satellite in the shape of a dumbbell inherently senses the direction of the vertical. The motion of such a dumbbell has been studied by first deriving the equation of motion of a point-mass satellite in a central force field—the classical two-body system—and then by extending the analysis to the modified three-body system which the dumbbell presents. The three equations of motion of the dumbbell are derived using Newton's laws, and then they are simplified by a series of approximations in order to compare the altitude and orbital motion of the dumbbell with the motion of a point-mass satellite. The complete equations of motion of the dumbbell are programmed on a digital computer for various initial orbital and dumbbell attitude conditions and for different dumbbell lengths. The results show that only in a circular orbit can the dumbbell ever be permanently aligned along the local vertical, and that for elliptical orbits of small eccentricity the dumbbell performs undamped sinusoidal oscillations of varying amplitude and frequency. In elliptical orbits of high eccentricity the dumbbell rotates almost continuously. The dumbbell length and its attitude motion do not perturb its orbit.

1,345 DISCONTINUED

1,346 SIMPLIFIED SATELLITE PREDICTION FROM MODIFIED ORBITAL ELEMENTS
Cormier, L. N., Goodwin, N., and Squires, R. K.
January 1, 1959
National Academy of Sciences, IGY World Data Center A,
National Research Council,
Washington, D. C.
IGY Satellite Report Series 7

The problem of supplying prediction data for IGY satellite observers is discussed in terms of the need for providing a large number of stations with fresh data in a useful form. A straightforward method is given whereby an observer can: (1) eliminate all but potentially significant observation periods, (2) for any such period determine the precise time when the satellite will cross (or approach) his latitude circle, the longitude of the crossing (or approach), and the satellite height, and (3) derive from such crossing (or approach) data the azimuth, elevation, and slant range to the satellite for one or more optical observations or comparable data for radio observations.

The method is specifically designed to direct primary consideration to the times when the orbit plane (without regard to the satellite position) passes through a selected point on the observer's meridian. Modification of the orbital elements permits direct application of the observer's geographical coordinates for, first, determining the times of approach of the orbit plane and, then, for determining the relative position of the satellite.

1,347 **STUDY OF THE OSCILLATORY MOTION OF MANNED VEHICLES**
Sommer, S. C., and Tobak, M.
April, 1959
National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.
Memorandum 3-2-59A

An analysis is made of the oscillatory motion of vehicles which traverse arbitrarily prescribed trajectories through the atmosphere. Expressions for the oscillatory motion are derived as continuous functions of the properties of the trajectory.

Results are applied to a study of oscillatory behavior for re-entry vehicles which have decelerations that remain within limits of human tolerance. It is found that a deficiency of aerodynamic damping may have more serious consequences for such vehicles than for comparable ballistic missiles.

1,348 **THE EFFECT OF LIFT-DRAG RATIO AND SPEED ON THE ABILITY TO POSITION A GLIDING AIRCRAFT FOR A LANDING ON A 5000-FT RUNWAY**
Reeder, J. P.
April, 1959
National Aeronautics and Space Administration, Langley Research Center, Langley Field, Va.
Memorandum 3-12-59L

Flight tests were made to determine the capability of positioning a gliding airplane for a landing on a 5000-ft runway with special reference to the gliding flight of a satellite vehicle of fixed configuration upon re-entry into the earth's atmosphere. The lift–drag ratio and speed of the airplane in the glides were varied through as large a range as possible. The results showed a marked tendency to undershoot the runway when the lift–drag ratios were below certain values, depending upon the speed in the glide. A straight line dividing the successful approaches from the undershoots could be drawn through a lift-drag ratio of about 3 at 100 knots and through a lift–drag ratio of about 7 at 185 knots. Provisions of a drag device would be very beneficial, particularly in reducing the tendency toward undershooting at the higher speeds.

1,349 OPTIMIZATION OF MICROLOCK STATION LOCATIONS FOR CLUSTER TRACKING
Clugston, P., and Kurtz, F.
March 30, 1959
Aeroballistics Laboratory
Army Ballistic Missile Agency, Huntsville, Ala.
DA Technical Note 30-59

A limited study is given which illustrates a method of selection of possible Microlock station locations for one-way doppler tracking of the cluster stages of vehicles of the Juno I and Juno II type. Station locations considered are strongly restricted by practical considerations, and the study is based on the cluster evaluation method presently in use. Three typical cluster trajectories are considered, two for Juno I vehicles and one for the Juno II vehicle. The Juno II example was utilized for choosing station locations for missile AM-14. It is to be noted that detailed results shown apply only to specific trajectories and must not be extended to other missions.

1,350 DESCRIPTION OF WORLD NETWORK FOR RADIO TRACKING OF SPACE VEHICLES
July 1, 1958
Jet Propulsion Laboratory, California Institute of Technology, Pasadena
Publication 135

A world-wide network of tracking stations is being established for tracking space vehicles. Each station in the radio tracking net resembles a radio astronomy station to which data-analysis and communication facilities have been added. Some of these stations may eventually contain transmitters to measure range and send commands to the vehicle.

In order to maintain continuous contact with the vehicles, tracking stations are planned for optimum locations throughout the world. At least three stations will be built near the tropic zone (California, Africa, and the East Indies), and two stations are planned for the Arctic. These stations must be shielded from civilization by terrain. The reason for this is the necessity of maintaining an extremely low ambient noise level in the vicinity of the station.

In this report the facilities necessary for successful operation of these stations area outlined.

1,351 THREE-DIMENSIONAL LUNAR MISSION STUDIES
Michael, W. H. Jr., and Tolson, R. H.
1959
National Aeronautics and Space Administration,
Langley Research Center, Langley Field, Va.
Memorandum 6-29-59L

Some three-dimensional lunar trajectories have been calculated by integration of the equations of motion of the classical restricted three-body problem of celestial mechanics. The calculations have been used for analysis of several aspects of lunar flight including requirements for achieving lunar impact and establishing a close lunar satellite. The allowable errors in initial conditions for lunar missions are strongly dependent on the values of the initial injection velocity and the injection angle. There can be large differences in results obtained from two-dimensional analyses (in which the vehicle trajectory is assumed to remain always in the earth–moon plane) and those obtained from three-dimensional analyses. Some of the accuracy tolerances can be fairly well estimated by use of a two-body analysis which considers the inclination of the plane of the vehicle trajectory to the earth–moon plane. Satisfactory orbits for a relatively close lunar satellite can be obtained with accuracies in the initial conditions approximately equal to those required for lunar impact.

1,352 STUDY OF THE GEOMAGNETIC FIELD FROM ARTIFICIAL SATELLITES AND ROCKETS
Pushkov, N. V., and Dolginov, S. Sh.
***Uspekhi Fizicheskikh Nauk*: v. 63, no. 4, pp. 645-656, 1957**
Hope, E. R., translation
Directorate of Scientific Information Service,
Defence Research Board, Canada
T 276R

In this paper some of the geophysical and technical aspects of geomagnetic measurements from satellites are reviewed. The problems encountered are discussed. Possibilities of future uses of satellites in this field are presented and magnetometers suitable for such work are described.

1,353 SCIENTIFIC RESULTS FROM THE EXPLORER SATELLITES
Hibbs, A. R.
June 2, 1958
Jet Propulsion Laboratory, California Institute of Technology, Pasadena
External Publication 514

A brief history of Explorer satellite launchings together with a description of payload instrumentation is given. A summary is presented of results of experiments made in the following areas: temperatures of both case and internal instrumentation, micrometeorite activity, and cosmic ray intensity. The results of preliminary analyses of these various measurements as carried out by the responsible institutions are given together with a discussion of their implications for future measurements of this type.

1,354 JOINT HEARING BEFORE THE PREPAREDNESS INVESTIGATING SUBCOMMITTEE OF THE COMMITTEE ON ARMED SERVICES AND THE COMMITTEE ON AERONAUTICAL AND SPACE SCIENCES, UNITED STATES SENATE
U. S. Congress,
86th, First Session
January 29 and 30, 1959
United States Government Printing Office
Washington, D. C.

The discussions presented arise from two questions: (1) "Is the United States doing everything it reasonably can and should do to ensure the defense of this country and the free world against military aggression?" and (2) "Is the United States doing everything it reasonably can and should do in the exploration of outer space?" The defense and space exploration budgets are briefly discussed. Organization of the national space program is presented. Missiles and the possible military applications of satellite vehicles are discussed.

1,355 THE ORBIT OF SATELLITE 1958 ZETA
Veis, G.
March 30, 1959
Smithsonian Institution, Cambridge, Mass.
Astrophysical Observatory
Special Report 23

This paper reports a preliminary orbital analysis of satellite 1958 Zeta. Expressions are given for the orbital elements as derived from the analysis of about

780 observations. A discussion of the orbital acceleration and related problems is presented. The geographic position of the satellite at five-minute intervals and a table of the observations received prior to February 1959 are given. The analysis is of a preliminary nature, as the photographic observations have not been reduced precisely and only first-order theory has been used. Most of the work was performed during the lifetime of the satellite for tracking purposes.

1,356 **CATALOGUE OF SATELLITE OBSERVATIONS FOR JANUARY AND FEBRUARY, 1959**
Albert, R. G., and Adams, R. M.
April 9, 1959
Smithsonian Institution, Cambridge, Mass., Astrophysical Observatory
Special Report 24

This report is a catalogue of all artificial earth satellite observations other than Minitrack and doppler received by the Smithsonian Astrophysical Observatory.

1,357 **PROCEEDINGS OF LUNAR AND PLANETARY EXPLORATION COLLOQUIUM**
July 15, 1958
North American Aviation, Inc., Los Angeles, Calif.
Vol. 1, No. 2

The following papers are included: "A Look at the Future Space Effort," "Guidance and Control of Space Exploration Vehicles," "Lunar Vehicles," "Syntax of Space Exploration," and "Making Measurements by Hard-Landing Vehicles." Two discussions are presented: one is a discussion of the papers given and the other a discussion of a lunar measurement program. A list of the colloquium members is also included.

1,358 **A CADMIUM SULFIDE SOLAR GENERATOR**
Hammond, D. A., Shirland, F. A., and Baughman, R. J.
December, 1957
Aeronautical Research Laboratory, Wright Air Development Center, Wright-Patterson AFB, Ohio
WADC Technical Report 57-770 (ASTIA AD-151,036)

The efficiency of CdS photovoltaic cells has been increased to a range of 3 to 5%, from an average of 0.4%. This has been effected by improved doping, growth, cleaning, and electroding techniques.

The method developed for making CdS cells is as follows: G.E. Luminescent Grade CdS, doped with 0.02% In_2S_3 and 0.10% Cd metal is grown into a large-grained polycrystalline ingot. The individual grains are separated and cut into cell-sized single crystals approximately 6 mm wide, 2 mm thick and as long as the grain permits—usually about 8 mm. A collector electrode of zinc is electroplated around the periphery of the front surface. The back surface is freshly lapped with 1000 grit Al_2O_3, etched in concentrated HCl and barrier electroded from a $Cu(NO_3)_2$ plating bath. After a short heat treatment, about 10-20 seconds at 350°C, the barrier is contacted with Silver Print or with evaporated silver or gold to complete the cell.

Two small solar energy generators were assembled from such cells for demonstration and testing purposes. Each of these gave about 50 milliwatts of power at about 6-7 volts when illuminated by direct sunlight.

1,359 THE NEXT TEN YEARS IN SPACE 1959–1969
U. S. Congress
85th Congress, First Session
House Document No. 115

Fifty scientists, engineers, industrialists, military officials, and government administrators discuss what can be expected in the next ten years in the field of space exploration. A summary of their opinions is presented together with the complete reports of the participants.

1,360 NOTES ON NUCLEAR AUXILIARY POWER UNITS (APU) FOR NASA DEEP SPACE MISSIONS
Lafyatis, P. G.
May 13, 1959
Jet Propulsion Laboratory,
California Institute of Technology, Pasadena
Section Report 22-4

Previous research results have indicated that solar energy might not be adequate as a power source for some deep-space missions. Consequently, the use of nuclear energy must be considered. Some problems associated with nuclear-energy power sources are public disapproval, the high cost of materials, and the possibility of space body contamination. This report contains tables of cost estimates for various isotopes under consideration and lists of proposed NASA deep-space missions, with corresponding suggested power sources.

1,361 FUNDAMENTAL INVESTIGATION OF ELECTRICAL POWER SOURCES FOR ELECTRIC THRUST DEVICES—MORPHOLOGY
Hellund, E. J.
September 3, 1958
Plasmadyne Corp., Santa Ana, Calif.
TN 58-790 (ASTIA AD-202,223)

A survey and classification have been made of various types of power sources which might possibly be used in conjunction with propulsion systems for space vehicles. Codification of these types has been systematically developed, the objective being to provide a convenient classification by means of which a rapid evaluation of any new proposals can be made. A number of possible new power systems and propulsion systems have been introduced.

The primary goal in system evaluation is to obtain an unambiguous upper limit to performance, equivalent to that derived for heat engines on the basis of the Carnot cycle. From the examples given it can readily be observed that the basic conservation laws of physics are usually sufficient to settle the question of feasibility in regard to any proposal.

1,362 SYMPOSIUM ON PROBLEMS IN SPACE EXPLORATION
Whipple, F. L., Gold, T., Parker, E., Christofilos, N., and Van Allen, J. A.
April 29, 1959
National Academy of Sciences, Washington, D. C.

The papers given are primarily concerned with space phenomena as a hazard to space flight. The problems include space particles (particles larger than a molecule but smaller than a planet), particle populations in the vicinity of the earth, plasma and magnetic fields in the solar system, the solar corona as it affects interplanetary space, and the location and intensity of the earth's magnetic field. A round table discussion is included.

1,363 RECORD OF NATIONAL SYMPOSIUM ON EXTENDED RANGE AND SPACE COMMUNICATIONS
October 6-7, 1958
Institute of Radio Engineers, New York, N. Y.
Symposium Papers

This conference was particularly concerned with the use of artificial satellites as passive reflectors. Several papers were presented on the subject of communication via meteor trails.

1,364 A CONTRIBUTION TO THE THEORY OF METEOR ABLATION
Sutton, G. W.
March 25, 1959
General Electric Co., Philadelphia, Pa.

In the interest of better understanding of re-entry phenomena, exact calculations have been performed of the stagnation point melting of a nonrotating iron meteor for that portion of the meteor trajectory which is below 200,000 ft altitude. It is found that if the surface remains smooth there is little likelihood of vaporization from the surface of the molten layer, which confirms Opiks' conclusions, although there is a large difference in the calculated temperature rise across the molten layer.

1,365 TESTIMONY OF ANDREW G. HALEY BEFORE THE COMMITTEE ON SCIENCE AND ASTRONAUTICS OF THE U. S. HOUSE OF REPRESENTATIVES: RADIO AND TELEVISION COMMUNICATIONS—SPACE SERVICE AND EARTH/SPACE SERVICE
Haley, A. G.
March 4, 1959
U. S. Congress, House of Representatives

Material is divided into the following sections: Comments on Jurisdiction; Sixteenth Notice of Inquiry, Federal Communications Commission, in the Matter of Revision of the Radio Regulations of the International Telecommunication Union; Comments of the American Rocket Society as to the Sixteenth Notice of Inquiry; the International Telecommunication Union; Public Notice, Federal Communications Commission, "Letter to Press Wireless Regarding Space Communication"; United Press International News Service Article, "Would Moon Hit Validate Claim?"; Conclusions. The Appendix contains notes on curriculum, *vitae*, and contributions by Andrew G. Haley on Space Law, Metalaw, Astronautics, International Relations.

1,366 TEMPERATURE CONTROL IN THE EXPLORER SATELLITES AND PIONEER SPACE PROBES
Buwalda, E. P., Hibbs, A. R., and Thostesen, T. O.
May 7, 1959
Jet Propulsion Laboratory,
California Institute of Technology, Pasadena
External Publication 647

The Jet Propulsion Laboratory participated in the Explorer and Juno II programs in the areas of payload design and method of achieving temperature control. This publication describes the basic theory for the passive temperature control of satellites and space probes and the application of this process to the Explorers and Pioneers III and IV. Some results of in-flight temperature measurements are also presented.

1,367 DISCONTINUED

1,368 CONTRIBUTIONS OF THE EXPLORER TO SPACE TECHNOLOGY
Froehlich, J. E., and Hibbs, A. R.
September 3, 1958
Jet Propulsion Laboratory,
California Institute of Technology, Pasadena
Progress Report No. 20-359

The philosophy of the Explorer programs is presented and demonstrated in the description of missile design and flight operation of the Explorers. Scientific measurements of cosmic-ray intensity, temperature environment, and micrometeorite densities are described, and the significance of these measurements is discussed.

1,369 RADIATION INSTRUMENT USED IN LUNAR PROBES
Josias, C.
May 3, 1959
Jet Propulsion Laboratory,
California Institute of Technology, Pasadena
External Publication 635

This report describes the radiation experiments made in the Juno IIA missions. James A. Van Allen was responsible for definition of the experiment, calibration of the flight packages and interpretation of flight results. The design and construction of the electronic "radiation" package containing counters, pulse circuitry, a high-voltage supply, dc amplifiers, and data coding and compression devices were done at JPL. A discussion is given of the radiation device and how it was used in the space experiments.

1,370 A PRECISE ATTITUDE CONTROL FOR ARTIFICIAL SATELLITES
Oberth, H.
April 2, 1957
Army Ballistic Missile Agency, Huntsville, Ala.

An attitude control for artificial satellites is described. This control utilizes the "tidal forces" which are exerted upon the satellite. The great advantage in using this method of control is its precision. An accuracy of 0.0001 radian (21 sec) can be realized without difficulty. A disadvantage of this system is that it cannot be used alone. It must be complemented with some other means of control to bring the satellite to a desired attitude from which it can be further controlled by the method described herein. "Tidal forces" are defined, described, and calculated. Several technical proposals are given concerning their use for an attitude control.

1,371 AN ANNOTATED BIBLIOGRAPHY OF RAND SPACE FLIGHT PUBLICATIONS
February 10, 1958
RAND Corp., Santa Monica, Calif.
RM-2113 (ASTIA AD-150,655)

This bibliography lists all research memoranda papers of RAND Corporation and translations related to space flight that are currently available to industrial contractors and commercial organizations with the required "need-to-know." The period covered is from April through January 1958.

1,372 RESEARCH IN SPACE SCIENCE: THE STRUCTURE OF THE HIGH ATMOSPHERE. II. A CONDUCTION MODEL
Whitney, C. A.
April 20, 1959
Smithsonian Institution, Cambridge, Mass.
Astrophysical Observatory
Special Report 25

A continuation is presented of Special Report 21 on linear models of atmospheric density. This paper contains a conduction model of the atmosphere from 140 to 600 km.

1,373 PRELIMINARY RESULTS OBTAINED WITH CATALYTIC SURFACES IN THE UPPER ATMOSPHERE DURING BALLOON FLIGHTS. UPPER ATMOSPHERE RESEARCH REPORT NO. III
Brown, J. A., and Gavin, G. I.
December, 1958
Ballistic Research Laboratory, Aberdeen Proving Ground, Md.
Technical Note 1230

Using high-altitude balloons, preliminary investigation of recombination rates of atomic particles and free radicals was performed by exposing radiosonde thermistor elements specifically vacuum coated with silver and aluminum oxide. Positive results were obtained by the silver-coated thermistor, while the aluminum-oxide-coated thermistors showed negative readings, as was expected.

1,374 SOME PRACTICAL SUGGESTIONS FOR WORLD COOPERATION THROUGH THE INTERNATIONAL ASTRONAUTICAL FEDERATION (Presented at the Conference of the Space Law and Sociology Committee of the American Rocket Society, March 20, 1959)
Haley, A. G.
March 20, 1959

1,375 ON THE RADIATION HAZARDS OF SPACE FLIGHT
Van Allen, J. A.
May 1959
Department of Physics, State University of Iowa, Iowa City, Iowa
SUI-59-7

The implications of the cosmic ray information obtained from satellite vehicles and space probes in connection with future space flights are discussed. Source location, intensity, and effects of cosmic radiation are considered. The nature of the radiation trapped in the earth's magnetic field has been extensively investigated by the Explorers, Sputnik III, Pioneer IV, and Mechta. The results of these experiments are discussed here.

1,376 **A COHERENT MINIMUM POWER LUNAR-PROBE TELEMETRY SYSTEM**
Martin, B. D.
May 12, 1959
Jet Propulsion Laboratory,
California Institute of Technology, Pasadena
External Publication 610

The FM/PM telemetry system for the Pioneer IV lunar probe was an efficient minimum-power phase-coherent communication link. It was designed to have a total power output of 180 mw and to be capable of threshold performance at two moon distances, 500,000 miles.

In this paper, space communication is discussed, particularly as related to the design of the Pioneer IV telemetry system. Emphasis is placed on the subcarrier data link and on the high degree of modulation compatibility required by such a narrow-band system. The theoretical design criteria, information capacity, and actual implementation of this link are presented together with a summary of the actual system performance during the Pioneer IV experiment.

1,377 **SOME SUNSPOTS AND FLARE STATISTICS**
Bell, B., and Glazer, H.
1959
Smithsonian Institution, Washington, D. C.
Vol. 3, No. 4

A study of the relations between some properties of sunspots and geomagnetic conditions has been made, using data accumulated from 1937 to 1953. This study can be used to bring up to date and supplement some aspects of earlier studies on sunspots and solar flares and their relation to magnetic classes. It employs information on 5,940 sunspots (observed from 1937 through 1953 at the Mount Wilson Observatory and reported in the *Publications of the Astronomical Society of the Pacific*) and 8,403 flares reported during the same period in the *I.A.U. Quarterly Bulletin of Solar Activity*. For each sunspot group listed by Mount Wilson in the *P.A.S.P.*, the following quantities relevant to this discussion were accumulated on punch cards: magnetic classification, maximum magnetic field strength, a duration factor, and the number of flares observed in the region.

1,378 **DOPPLER WIDTHS OF SOLAR ABSORPTION LINES**
Bell, B., and Meltzer, A.
1959
Smithsonian Institution, Washington, D. C.
Vol. 3, No. 5

In an attempt to distinguish the contributions of turbulence and kinetic temperature to the half-widths of solar absorption lines, photoelectric tracings were made of the profiles of twenty-two moderately weak lines of three elements covering a wide range in atomic weight (μ): carbon (12), silicon (28), and iron (56). The tracings were analyzed by the method of Voigt functions. In iron, to be as nearly comparable as possible with the available lines of silicon and carbon, only lines of relatively high (>4.1 ev) excitation potential were used.

When the μ-dependent and the μ-independent parts of the doppler half-widths were separated, a kinetic temperature of the order of 10,000°K was obtained. Temperatures of the same order, or somewhat higher, are indicated if the damping is neglected and the entire half-width is assumed to arise from doppler broadening.

1,379 **FINAL REPORT ON PROJECT ESP-27 TO THE WORKING GROUP ON INTERNAL INSTRUMENTATION OF THE TECHNICAL PANEL ON THE EARTH SATELLITE PROGRAM**
May 19, 1959
Jet Propulsion Laboratory,
California Institute of Technology, Pasadena
Publication 163

Project ESP-27 consists of two separate experiments. Feasibility studies and preliminary designs have been completed for each of these two endeavors. The first experiment measures the integrated light arriving from different parts of the extraterrestrial sky. The mechanical portion of the apparatus consists of a rotatable mirror, a lens, and a set of color filters; the electronic portion contains a multiplier phototube, a logarithmic amplifier, various telemetering circuits, and a safety device. Light of various wavelengths and from various directions is viewed by the multiplier phototube in a certain sequence. The data collected in this experiment may facilitate the distinction between cosmological models. The satellite photometer also affords a prolonged view of the airglow from above and a view of the zodiacal cloud that is better than has ever before been possible. Also, the galaxy will be mapped in the extraterrestrial ultraviolet portion of the spectrum.

The second experiment measures cosmic ray flux with an automatic ionization chamber. This chamber is a ruggedized version of one used extensively by other workers in balloon-borne experiments. It is insensitive to variations in charging voltage and has other features, e.g., very low battery drain, which make it especially suited for use in a satellite. The electronic portion of the experiment is entirely transistorized.

Development has extended beyond the prototype stage for the photometer but has stopped with a feasibility study for the ionization chamber. Working models of the entire photometer and of the electronics of the ionization chamber have been built. Data transmission and reception techniques similar to those already successfully employed in the Explorer satellites are planned.

1,380 **THE AEROSPACE INDUSTRY: A REPORT ON PLANTS AND FACILITIES**
Judge, H. C.
1958 (Third Edition)
Aero/Space Engineering
New York, N. Y.

This edition of *The Aerospace Industry* presents a compilation of the plants and facilities in the United States engaged in the research, design, or manufacture of airframes and propulsion units for aircraft, missiles, rockets, and outer-space vehicles. Also included is a representative list of the manufacturers of complete systems for air and space vehicles.

1,381 **HISTORY OF RESEARCH IN SUBGRAVITY AND ZERO-G (1948-1958)**
Hanrahan, J. S.
May,1958
Air Force Missile Development Center,
Holloman Air Force Base, N. M.

The subjects of subgravity and zero gravity are studied in the form of an historical essay. Methods of studying various types of subjects (human, feline, rodent, etc.) are discussed and results of the experiments are given.

1,382 **SATELLITE ACQUISITIONS AND REQUIREMENTS FOR OPTIMUM OPTICAL TRACKING**
Grigsby, D. L.
March, 1959
Army Missile Test Center,
White Sands Missile Range, N. M.
Special Report 12

Part I of this report gives a method of finding a satellite's location in its orbit, its time of arrival, its altitude at this point, its angle of elevation from a tracking position, the latitude and longitude of the satellite subpoint, and its great circle distance and azimuth from this tracking position.

It is possible from the calculations given in Part II to obtain the optimum times and locations of the satellite for optical tracking.

1,383 VARIATIONS FROM CIRCULAR ORBIT AS NONLINEARIZED FUNCTIONS OF THE INJECTION PARAMETERS
Silber, R.
April 20, 1959
Aeroballistics Laboratory
Army Ballistic Missile Agency, Huntsville, Ala.
Report DA-TR-5-59

This report presents the results of an investigation for near-circular orbits concerning the relationship of the orbital characteristics to the injection conditions. General formulas are derived and evaluated in graphical tabular form. The effects of injection altitude variations, injection velocity variations, injection path angle variation, and all combinations of these are given. The variations are restricted to the standard plane and are evaluated for eccentricity of the orbit, the altitudes of apogee and perigee, and the location of the apsides in the orbit with reference to the point of injection. Beyond this, the information about altitude changes due to injection parameter variations is extended to cover changes at any point on the orbit. The report also shows that by expressing the changes in injection velocity and injection altitude in nondimensional fractional form, exact formulas of simple structure can, in most cases, be developed. Where simplicity of structure cannot be achieved, no simplifying approximations are given, with the result that all formulas are exact for all magnitudes of injection parameter variations. For purposes of this investigation, a homogeneous spherical earth is assumed and the resultant orbits are therefore ideal ellipses.

1,384 RADIOACTIVE AGGREGATES IN THE STRATOSPHERE
Yagoda, H.
March, 1959
Air Force Cambridge Research Center, Bedford, Mass.
AFCRC-TN-59-201 (ASTIA AD-212,423)

Dust collected from two balloon flights at 100,000- and 112,000-ft elevations have been tested for radioactivity by incorporating the dust particles into a nuclear emulsion and developing the tracks produced by associated alpha and beta particle emissions. The dust collected on a balloon launched at Minneapolis, Minn., on August 16, 1958, exhibited 1.7 radioactive dust particles per sq cm of collector surface after 11.5-hr flight above 60,000 ft. The fission-colloid concentration on this flight is about 1500 times greater than the corresponding sea-level fallout in emulsions prepared in England in 1955. Details of emulsion preparation and development are described. A phenomenological classification of radioactive dust particles is presented together with photomicrographs of typical categories.

1,385 A NEW ANALYTIC REPRESENTATION OF SURFACE INTERACTION FOR HYPERTHERMAL FREE MOLECULE FLOW WITH APPLICATION TO NEUTRAL-PARTICLE DRAG ESTIMATES OF SATELLITES
Schamberg, R.
January 8, 1959
RAND Corp., Santa Monica, Calif.
Research Memorandum 2313 (ASTIA AD-215,301)

The forces on a body in free molecule flow are determined primarily by the nature of the interaction between individual gas molecules and the solid surface of the body. Existing data on such surface interactions are insufficient either for understanding the mechanism involved or for prediction of the effects of such interactions for specific combinations of gas molecule, surface material, etc.

In this memorandum, the customary analytic representation of the effects of surface interaction is re-examined and found to be unsatisfactory. An alternative representation for surface interaction is proposed and then used to calculate force coefficients of flat plates and convex bodies in free molecule flow. The simplest case of hyperthermal free molecule flow is discussed in detail because of its direct applicability to the estimation of the drag of artificial satellites in the upper atmosphere.

1,386 THE NASA SPACE SCIENCES PROGRAM
Office of the Assistant Director for Space Sciences
April 16, 1959
National Aeronautical and Space Administration, Washington, D. C.

The status of the national space science program is described. For convenience, the subject has been divided into several broad areas: atmospheres, ionospheres, energetic particles, electric and magnetic fields, gravitational fields, astronomy, and biosciences. For each area, the principal scientific objectives are stated, followed by a review of present knowledge and existing problems to be solved. Each section closes with a statement of the long-range program and the immediate program now under way.

1,387 IMPACT OF HIGH SPEED PARTICLES WITH SOLIDS AND GASES
Kells, M. C., and Keough, D. D.
December 15, 1958
Stanford Research Institute, Menlo Park, Calif.
Poulter Laboratories
Technical Report 017-58

Work performed under this contract has resulted in development of the first successful technique for providing quantitative measurement of hypervelocity cratering variables using particles of less than about 150 microns in size.

The usefulness of the explosive acceleration technique was demonstrated by the calibration of two micrometeorite detector systems used in Aerobee rocket studies and in earth-satellite studies. The calibrations obtained agreed well with those determined by the customary bead-dropping procedure. The explosive technique was also used to demonstrate the fact that wire grid detector circuits will be opened by particles of approximately half the wire diameter traveling with velocities in the 4-6 mm/sec range.

The feasibility of using shaped charges for micrometeorite simulation for upper atmosphere research was demonstrated in an Aerobee flight on October 16, 1957. Charges were designed, prepared, and installed in the rocket to provide ionization sources for camera and radar studies. The charges produced the first man-developed objects to escape from the earth's gravitational field.

1,388 SATELLITES AND SPACE PROBES
Newell, H. E., Jr.
March 26, 1959
National Aeronautics and Space Administration,
Washington, D.C.
Space Science Lecture No. 4
NASA 59-109

A fundamental explanation of the mechanics of space trajectories is presented. The relationships of mass, speed, gravity, etc., employed in calculating these trajectories are explained.

1,389 POWER SUPPLY SOURCES FOR ARTIFICIAL EARTH SATELLITES
Grigorenko, E. A.
***Krasnaya Zvezda*, November 20, 1957, p. 3.**
Technical Documents Liaison Office,
Wright-Patterson AFB, Ohio
Translation F-TS-9587/III

Auxiliary power supplies for the Soviet artificial earth satellites launched during the IGY are evaluated in this paper. Photogenerators and thermogenerators are described. If sufficient advances can be made in developing these devices they would be excellent power-supply sources for artificial satellites.

1,390 THE TEMPERATURE OF AN OBJECT ABOVE THE EARTH'S ATMOSPHERE
Seavey, M. H.
March, 1959
Air Force Cambridge Research Center, Bedford, Mass.
AFCRC-TN-58-633 (ASTIA AD-208,863)

The equilibrium temperature of an object above the earth's atmosphere is calculated by considering the thermal radiation balance for the object. Object parameters such as height above earth, shape, thermal conductivity, heat capacity, and surface absorptivity are treated, and it is shown that the latter is the most sensitive parameter in the temperature determination. Temperatures in the neighborhood of 300°K are predicted for gray bodies, but a range of 100°K below or above this temperature may be covered by varying the surface absorptivity characteristics.

1,391 PAYLOAD LOSS FOR EQUATORIAL ORBITS DUE TO NON-EQUATORIAL LAUNCHES
Eaton, M. L., and Garcia, M. A.
April 2, 1959
Pacific Missile Range, Point Mugu, Calif.
Publication PMR-MP-59-13

This report estimates a penalty for producing equatorial satellite orbits from launch sites off the equator. The penalty concerns the decrease in payload compared to launches from the equator. Two methods of obtaining an equatorial orbit from a non-equatorial launch site have been considered: apogee transfer and orbital transfer.

In addition to the latitude of the launch site, five key parameters are involved in the calculations. These are: fuel specific impulse, rocket structural factor, altitude of desired orbit, range to apogee of preliminary rocket trajectory, and ratio of the apogee and circular velocities. It is shown that the penalty increases with latitude, and that for even the most favorable selection of parameters the penalty is significant at rather low altitudes.

1,392 SPACE KNOWLEDGE AND ITS IMPACT ON FUTURE RESEARCH
Dryden, H. L. (NASA)
May 5, 1959
Industrial Research Institute,
Buck Hill Falls, Pa.

The discoveries of the first manmade satellites and space probes are reviewed. Programs of the NASA agency which are in the development stages are described. The five areas of most interest in NASA's program are: (1) atmospheric studies of the earth, moon, sun, and planets, (2) study of the ionosphere, (3) cosmic radiation, (4) magnetism, electricity, and gravity and (5) astronomy (especially orbital observatories). Special emphasis is placed on the manned satellite project.

1,393 SCIENTIFIC RESULTS FROM THE EXPLORER SATELLITES AND THE PIONEER SPACE PROBES
Hibbs, A. R.
May 15, 1959
Jet Propulsion Laboratory, California Institute of Technology, Pasadena
External Publication 649

During 1958 and the first few months of 1959, the United States contributed to the scientific program of the IGY with the launching of instrumented artificial earth satellites and space probes. These flights represent the first portion of a continuing program of space exploration on the part of the U.S. This paper describes the instrumentation of Explorers I, III, and IV, and of Pioneers III and IV, and gives the results obtained from these tests, including the discovery of the two Van Allen radiation belts, the measurement of interplanetary dust density, and the feasibility of temperature control for a body in free space.

1,394 MEASUREMENT OF THE ELECTRIC CHARGE OF A SATELLITE
Singer, S. F.
March 31, 1959
Physics Department, University of Maryland, College Park
Final Report on Grant NSF/IGY-32.2/216

A literature survey was undertaken to ascertain the best values for the environmental parameters in a satellite orbit. These parameters include the gas temperature, the average velocities of ions and electrons and their respective temperatures, the gas density, and the degree of ionization. From these data, an estimate of the electrostatic potential of a satellite is determined. Photo-emission of electrons from the satellite skin is the primary investigation undertaken in this report. The hot-probe technique is given careful consideration, and the components for such a probe are described.

1,395 DISCONTINUED

naut was of primary importance and that the highest degree of reliability should be engineered into the program. (2) The committee felt that the astronaut should have voice communication with the ground during 100 per cent of his orbit. The discussion of this point was prompted by the fact that, as the system now exists, there are about 20 minutes (of the 90-minute orbit period) during which the astronaut will not be able to communicate with the ground. (3) Regarding its future activities the committee felt that perhaps it could be useful in making recommendations to NASA management concerning longer-range bioscience research and in suggesting membership for a more permanent and broadened life sciences research advisory committee.

1,396 **THE CLOCK PROBLEM (CLOCK PARADOX)—IN RELATIVITY—THEORIES, BOTH PRO AND CON, RECORDED IN THE LITERATURE**
Benton, M.
May, 1959
U.S. Naval Research Laboratory, Washington, D. C.
Bibliography No. 15

Current interest in the possibilities of space flight and the prediction that atomic clocks in earth satellites may be utilized to check Einstein's theory have focused attention on the clock problem in relativity, or the so-called time-traveler paradox and its implication. General theory holds that a precise clock will run more slowly at extreme altitudes than an earthbound clock because of differences in gravitational fields. Special theory holds that the rates of two clocks will vary because of relative motion between the two. If two observers part company, travel with a relative speed, and rejoin one another, it is implied that one will record a shorter lapse of time than the other. Thus, a time advantage will exist for the traveler on an extended voyage. The question naturally arises: will space travel lengthen life?

This bibliography records the pros and cons of the debate which is currently being conducted in an attempt to resolve the problems implicit in the stated area.

1,397 **STAR FINDER AND IDENTIFIER NO. 2102D**
Collins, E. B.
1958
U.S. Navy Hydrographic Office, Washington., D. C.

This star finder and identifier is designed to portray graphically the approximate altitude and azimuth of the 57 numbered stars listed in the *Air and Nautical Almanacs* and any other celestial bodies that may be plotted on the star base.

1,398 GENERAL RESEARCH IN FLIGHT SCIENCES: VOLUME IV—FLIGHT DYNAMICS AND SPACE MECHANICS
Kanno, J. S. and Michielsen, H. F.
January, 1959
Lockheed Missiles and Space Division, Sunnyvale, Calif.
LMSD 48381

"Free Pitch-Yaw Dynamic Response of a Spinning Ballistic Body in a Time Varying Aerodynamic Environment," J. S. Kanno

An approximate analytical solution of a linear differential equation which describes "free" pitch-yaw spinning ballistic-body behavior in an arbitrarily varying aerodynamic environment is resolved by introducing a simplification in the normal form of the differential equation. The solution indicates the following basic result: A slowly changing envelope of the "free" epicyclic behavior is described by a modified form of the Friedrick and Dore equation, where the extent of the modification is the inclusion of a gyroscopic term. The accuracy of the approximate solution of the normal form of the differential equation is examined by use of a direct comparison of results of the asymptotic expansions of available exact solutions.

"Self-Sustained Epicyclic Pitch-Yaw Oscillations of a Spinning Ballistic Body Characterized by the Van Der Pol Damping Function," J. S. Kanno

Results are presented of a preliminary survey of ballistic body pitch-yaw cycle, or self-sustained oscillatory behavior. These results are intended to supplement an understanding of the limit-cycle phenomenon of the blunt-nosed ballistic re-entry body. The solution of the equation of motion is resolved by the approximate quasi-harmonic method of Kryloff and Bogoliuboff and indicates that the limit-cycle criterion is satisfied by four steady-state waveform configurational conditions of oscillation, one of which is shown to be the only stable condition.

"Orbit Decay and Prediction of the Motion of Artificial Satellites" H. F. Michielsen

The rate of decay of elliptic satellite orbits due to atmospheric drag is investigated through variation of parameters and use of an atmospheric model involving a power function between density and altitude. This model is shown to fit actual conditions better than an exponential function. The effects of the equatorial belt and the rotation of the earth are investigated. The conclusion is reached that, through these anomalies, atmospheric drag substantially affects the orbit elements, especially those defining the orbit plane. An alternative approach of variation of parameters is presented by which a direct relation between period decay, change in period decay, and instantaneous density conditions is established. Specifically adequate for prediction work, this approach also opens an avenue for systematic and unified evaluation of observed decay.

"Minimum Weight and Optimum Flight Path of Low-Acceleration Space Vehicles," H. F. Michielsen

Mass ratios of a low-thrust, high-energy space vehicle are optimized under the assumption that a fixed relation exists between the power and the weight of a device for generating and converting energy. It is shown that, in terms of total impulse, the performance can be improved by allowing for more time under power. An application to a round trip between satellite orbits around the earth and around Mars indicates that optimum operation requires considerable coasting periods between escape and capture maneuvers in the planets' gravitational fields. In addition, for best economy this coasting must not follow the Hohmann ellipse. It is found that, with a payload mass ratio of 4.3, actual travel time would require around 305 days to reach orbit around Mars and 260 days for return, with exploration time in the Mars orbit of about 500 days in between. This is based on most conservative assumptions, including the one concerning power—weight ratios based on information presented in recent publications.

1,399 THE INVESTIGATION OF THE PASSIVE STABILITY OF A SATELLITE VEHICLE
July 3, 1958
Aeronutronic Systems, Inc., Glendale, Calif.
Publication V-225

This technical note summarizes studies undertaken to determine the feasibility of a passive satellite altitude-control system. The system considered utilizes the satellite body and a pendulum of different libration frequencies with viscous coupling. This document summarizes those areas in which further investigation is needed.

1,400 VOLCANIC ACTIVITY ON THE MOON
Kozyrev, N. A.
***Priroda*, no. 3, pp. 84-87, March 1959**
U. S. Department of Commerce
Office of Technical Service,
Information on Soviet Bloc International Geophysical Cooperation—1959
Part III, April 24, 1959
PB 131,632-63

Kozyrev analyzes the observations that have been made of the moon's surface and gives his conclusions concerning the origin of its surface features. He claims that it is obvious that the irregularities are caused by repeated upheavals and subsidences of its crust. Some formations indicate a subsidence of part of the crust with the formation of cracks and the subsequent outpouring of a molten mass. The possibility of a lunar atmosphere considerably thinner than the earth's own atmosphere is discussed.

1,401 **CONTROLLED RECOVERY OF NON-LIFTING SATELLITES**
(Presented at the American Rocket Society Controllable Satellites Conference, Massachusetts Institute of Technology, April 30—May 1, 1959)
Detra, R. W., Riddell, F. R., and Rose, P. H.
AVCO–Everett Research Laboratory, Everett, Mass.
Research Report 54

This paper considers the problem of recovering, at a preselected site, satellites that are orbiting close to the earth (i.e., within a few hundred miles of the earth's surface). Considerations are limited to vehicles which accomplish re-entry into the atmosphere with drag devices. The discussion centers on two possible means of effecting controlled recovery of satellites.

1. Recovery accomplished by a single perturbation of the satellite orbit as may be done with a single solid-fuel retrograde rocket.
2. Recovery accomplished by continuous application of a small force of controllable magnitude. This could be done with a low-thrust controllable rocket motor or, if the satellite is orbiting in the outer fringes of the atmosphere, by varying the drag area of the vehicle.

These two cases may be considered as extremes in the way in which the perturbing forces can be applied. The "intermediate" case of a controlled recovery by a series of impulsive forces (e.g., by a number of small retro-rockets) is not considered.

1,402 **ROCKET PROPULSION SYSTEMS FOR INTERPLANETARY FLIGHT**
Sutton, G. P.
March 18, 1959
Massachusetts Institute of Technology, Cambridge
Lecture

A comparison is made of several different propulsion systems for interplanetary flight. Liquid- and solid-propellant rockets, propulsion systems which use nuclear energy sources, arc heating rockets, magneto-plasma devices, ion rocket propulsion, solar heating rockets, and solar sails are briefly described and their current status reviewed. Engine performance requirements for different interplanetary missions are established. These several propulsion systems are then compared on the basis of several performance criteria, environmental characteristics, vehicle requirements, reliability, current status, growth potential, and efficiency. Predictions on various propulsion system capabilities and an analysis of multiple rocket engine reliability is included. It is concluded that electrical rockets are superior for long-time interplanetary flight applications, and that chemical rockets are satisfactory for most of the immediate applications in "near" space. None of the several propulsion schemes discussed can be rejected until further technical work has been accomplished.

1,403 AMATEUR MICROLOCK HANDBOOK
Butler, C. T. and Richter, H. L., Jr.
1959
Jet Propulsion Laboratory, California Institute of Technology, Pasadena

The purpose of this manual is to document the amateur Microlock installation used by the San Gabriel Valley Radio Club for satellite tracking. The design for the station was adapted from the Microlock system developed by the California Institute of Technology Jet Propulsion Laboratory. The Club equipment utilizes standard Microlock circuits with certain simplifications which bring it into the realm of amateur facilities. The receiver presented here is only one of many possible variations of the basic phase-locked receiver. Those who build it are urged to add innovations of their own. As experience is gained in the use of the Microlock principle, new uses and forms of the receiver will doubtlessly suggest themselves. The purpose of this particular station is twofold: to provide a very sensitive receiver to receive satellite signals on 108 megacycles, and to provide a sensitive receiver for experimenting with amateur communications in the vicinity of 146 megacycles under unusual conditions.

Much of the equipment was used to track the first Russian satellite in the fall of 1957. Since that time, modifications have been made to enable the entire Microlock system to receive the 40-megacycle frequency used by the Russians. The equipment was used in its full form for tracking the various American satellites in 1958.

1,404 EPHEMERIS OF SATELLITE 1957 ALPHA 2
Eckels, A., Koidan, R., Harris, I., and Jastrow, R.
April 1, 1959
National Aeronautics and Space Administration, Washington, D.C.

1,405 SILICON SOLAR BATTERIES AS SOURCES OF ELECTRICAL POWER FOR ARTIFICIAL EARTH SATELLITES
Vavilov, V. S., Malovetskaya, V. M., Galkin, G. N., and Landsman, A. P.
Uspekhi Fizicheskikh Nauk, Vol. LXIII, No. la, September, 1957
Kuvshinoff, B. W., translation
Johns Hopkins University, Silver Spring, Md., Applied Physics Laboratory
TG 230-T6

The authors discuss the design, construction, operation, and theoretical and experimental characteristics of photoelements employing silicon p-n junctions to transform solar radiation into electrical energy.

1,406 ON THE POSSIBILITY OF EXTRACTING ENERGY FROM GRAVITATIONAL SYSTEMS BY NAVIGATING SPACE VEHICLES.
Vlam, S.
April 1, 1958
Los Alamos Scientific Laboratory, of the University of California, N. M.
LAMS-2219

In this brief report are problems of the following type: It is assumed that an astronomical system composed of two or more stellar bodies and a space vehicle which, as an additional body of infinitely small mass compared to the celestial objects, forms part of a many–(e.g., 3)–body system. It is also assumed that the "rocket" not only describes the trajectory under the action of the gravitational forces, but also that it has still a reserve energy available for steering by suitably emitted impulses. This energy in the discussion will be assumed to be roughly of the order of the kinetic energy which the rocket already possesses. The problem, broadly speaking, involves the possibility of using this reserve energy in such a way as to acquire, by suitable near collisions with one or the other of the celestial bodies, much more kinetic energy than the rocket possesses—more by an order of magnitude than the available reserve energy would allow it to acquire by itself.

1,407 HISTORY OF RESEARCH IN SPACE BIOLOGY AND BIODYNAMICS (1946–1958)
Hanrahan, J. S., and Bushnell, D.
December, 1958
Air Force Missile Development Center
Holloman Air Force Base, N. M.

This report describes the work that has been done at the Air Force Aeromedical Field Laboratory since 1946. An accurate but not too technical account is given of the methods and equipment used in each experiment and the results which were obtained.

1,408 WATER-LANDING IMPACT ACCELERATIONS FOR THREE MODELS OF REENTRY CAPSULES
Vaughan, V. L. Jr.
August, 1959
National Aeronautics and Space Administration
Langley Research Center, Langley Field, Va.
Technical Note D-145

Experimental investigations have been conducted to determine the rigid-body impact accelerations for three models of reentry capsules during simulated parachute-supported water landings. The main bodies of the models were conical in shape. Two of the models were 1/12 scale; one had a segment of a sphere as a bottom and the other had a 53 deg conical shape as a bottom. The third model was 1/6 scale and had a convex-concave bottom. The models were tested for nominal flight paths of 90 deg (vertical) and 65 deg to simulate parachute landings with no wind and with wind, respectively, and nominal contact attitudes of ± 30 deg, ± 15 deg, and 0 deg to simulate attitudes that might occur as a result of swinging of the capsule under the parachute. Accelerations of the models at impact were measured along the X (roll) and Z (yaw) axes by accelerometers installed at the centers of gravity.

The maximum accelerations along the X-axis for the three forms were higher for inclined flight-path angles than for the vertical flight path, and varied as the square of the vertical contact velocity for a given shape, flight path, attitude, and mass. The accelerations along the Z-axis were small for the models with the spherical and conical bottoms at a contact attitude of 0 deg regardless of flight-path angle and small (up to 3 g) for the model with the spherical bottom for all test conditions.

1,409 HISTORICAL SURVEY OF INHABITABLE ARTIFICIAL ATMOSPHERES
Ashe, W. F., Wright, C. C., Anderegg, J. W., Carlisle, H. N., and Haub, J. G.
September 1958
Wright Air Development Center, Wright Patterson AFB, Ohio
WADC TR 58-154 (ASTIA AD-155,901)

The unclassified world literature on the production and control of artificial atmospheres for living organisms was surveyed. This survey covered literature in the fields of human biology and medicine, microbiology, botany and zoology. All pertinent articles were abstracted. These abstracts, together with the authors, title, and source of each article, make up the body of this report. Abstracts were arranged under the following groups: Carbon Dioxide, Carbon Dioxide Removal Systems, Carbon Dioxide at High Partial Pressure, Electromagnetic (Including Cosmic) Radiation, Variation of "G" Forces, Heat-Cold and Temperature Regulation, Noise, Oxygen, Oxygen Generation, Oxygen at High Partial Pressure, Oxygen Instrumentation, Oxygen at Low Partial Pressure, Odor, Pressure, Pressure Low, Pressure Explosive Decompression, Sealed Cabins or Containers, Toxic Substances, Water and Moisture Control, Miscellaneous Factors.

Each abstract was given a five-unit code symbol for ease of cross reference among the four major fields of investigation. No conclusions were made by the authors as to the potential value of any abstract in the production of any desired atmosphere.

1,410 EQUATIONS OF MOTION OF SATELLITE IN UPPER REGION OF THE EARTH'S ATMOSPHERE
Lundquist, C. A.
April 18, 1955
Ordnance Missile Laboratories, Army Rocket and Guided Missile Agency, Redstone Arsenal, Ala.
Report 6M64 (ASTIA AD-105,883)

The equations of motion of a satellite under the influence of the gravitational field of the earth and a drag force due to air resistance are formulated. Effect of the rotation of the atmosphere is discussed.

1,411 LIFETIME OF ARTIFICIAL SATELLITES OF THE EARTH
Henry, I. G.
Aerojet-General Corp., Azusa, California
(ASTIA AD 121,220)

Attention has centered recently on the placing of small artificial satellites in orbits about the earth. These satellites would be retarded by the atmosphere and would ultimately spiral down and be destroyed. Their initial height is such that the drag is caused by individual molecular impacts and is calculable from kenetic theory. This article will attempt to estimate the lifetime of such a satellite starting in an elliptical orbit which is nearly circular, say of radius 4500 miles, radial oscillation $\pm$ 250 miles.

1,412 MISSILE DEVELOPMENT AND SPACE SCIENCES
(Hearings before Committee on Science and Astronautics, U. S. House of Representatives)
U. S. Congress
86th, First Session
February 2-5, 9, 10, 17, 18, 24, March 2 and 12, 1959
United States Government Printing Office, Washington, D. C.

Objectives of and progess made in the United States space research program are discussed. The military applications of the space research program and the guided missiles being developed and now in use by the military are reviewed.

1,413 DISCONTINUED

An experimental investigation has been made in the Langley full-scale tunnel to determine the low-speed static aerodynamic characteristics of a full-scale model of a reentry capsule. Static data are presented for the space capsule with a 40-in. and a 70-in. canister for an angle-of-attack range from -5 deg to 88.7 deg. Also included are the effects of a corrugated canister surface on the static stability characteristics. The test Mach number was 0.10 and the Reynolds number was 4.85×10^6 based on the maximum body diameter.

1,414 ASTRONOMICAL PHENOMENA FOR THE YEAR 1961
Nautical Almanac Office
U.S. Naval Observatory, Washington, D.C.

This pamphlet contains information on religious calendars, government holidays, sunrise, sunset, moonrise, moonset, beginning and end of astronomical twilight, and also eclipses of the sun and the moon.

1,415 STUDY AND DESIGN OF UNFURLABLE ANTENNAS (VOLUME II. ENVIRONMENT AND PROPAGATION STUDY)
November 30, 1958
Lockheed Aircraft Corp., Van Nuys, California
LMSD-48346

Volume II of this study contains the most recent available information on space environment factors, as they can affect the design of unfurlable antennas, Effects of atmospheric drag on satellite lifetime are discussed as a function of the unfurled antenna area, along with the effects of high vacuum, temperature, and such atmospheric constituents as dissociated gases and solid particles. Recent information on space radiation is outlined, and included is a list of dielectric materials classified according to their resistance to radiation.

Propagation phenomena connected with the transmission of signals through the earth's atmosphere produce certain limitations. The types of propagation effects important to the unfurlable antenna program are refraction, attenuation, Faraday effect, and frequency dispersion. The study contains an analysis of the limitations introduced by these phenomena.

Satellite stability disturbances due to unfurlable structures and to internal rotating masses are also analyzed. Unfurlable structures may introduce stability disturbances by component accelerations during the unfurling process, by shifts of the center of mass, and by changes in the relation of the moments of inertia of the vehicle. Important to the program are rotating mass effects which may be classified as gyroscopic and non-gyroscopic. The study presents a simplified form of equations describing the stability of an orbiting vehicle.

1,416 CORRECTION OF EPOCH ERROR IN CIRCULAR ORBITS. PART 2: CORRECTION BY NON-TANGENTIAL TRANSFER.
Berman, L. J.
Massachusetts Institute of Technology
April 30, 1959
Air Force Office of Scientific Research, Washington, D.C.
AFOSR Technical Note 59-62 Part 2
(ASTIA AD-214,637)

A vehicle in a circular orbit is transferred into a second orbit by impulsive thrust. At some subsequent intersection of the two orbits, a second impulse is applied to transfer it back to the original orbit. In general, the average angular velocity in the transfer orbit will differ from that in the circular orbit, and the epoch of the body will be changed by such a maneuver.

This maneuver is studied with an objective of determining what conditions affect choice of the transfer orbit. In particular the time taken for completion of the epoch change and the characteristic velocity required are studied. Finally it is shown that the imposition of a restriction on the minimum perigee radius considerably modifies the choice and even makes some conditions impossible to satisfy.

1,417 RADIO ASTRONOMY
Sweitzer, D. I.
May 1, 1959
Jet Propulsion Laboratory, California Institute of Technology, Pasadena
Astronautics Information, Literature Search No. 60

Reports and outside literature concerning the reception of extraterrestrial radio-frequency radiation and the observation of astronomically near masses by means of reflected waves are listed. The bibliography is slanted toward the instrumentation used. Section II of the list gives information on observatories and instrumentation. Section III deals with data for solar system radiation, the data from outside our solar system, and radar observations. Section IV includes theory of radiation and interpretation of data. The literature was searched only through mid-spring of 1958.

1,418 RECORDING THE TIME WHEN PHOTOGRAPHING ARTIFICIAL EARTH'S SATELLITES
Lipskii, IU. N.
Astronomicheskii Zhurnal: v. 35, no. 2, pp. 301-304, 1958.
Morris D. Friedman, Inc.
Foreign Technical Translations
West Newton 65, Mass.
L-122

A photo-electric method of recording the time was used in the P. K. Shternberg Astronomical Institute when photographing the artificial earth's satellites. An illuminator with a filter (which would give a parallel beam of infrared rays directed through the lens into the camera where a photo-conductor with a maximum response in the 2.5 μ range was placed) was built in front of the lens of a special photographic chamber and on the side of its holder. The lens focussed the beam onto the photo-conductor which was connected to an oscilloscope which recorded the whole operating cycle of the shutter and the marks of the exact time. The error in determining the instants of the middle of the exposures of the separate strokes on the photographic plate do not exceed 0.001–0.003 sec in a relative system of time of the given clocks, which permits the angular velocities, altitudes and other data on the satellite flight to be compared.

1,419 **PHYSIOLOGY OF LAUNCHING AND RE-ENTRY STRESS IN RODENTS**
Von Beckh, H. J.
August, 1958
Air Force Missile Development Center
Holloman Air Force Base, N. M.
Technical Note 58-11 (ASTIA AD-154,105)

Centrifuge runs with rodents are reviewed by several investigators. It is concluded that accelerative forces *per se* would not endanger these animals in biosatellite experiments. However, environmental stresses and the absence of gravity could lower their resistance, and therefore, a reliable *g*-protection for the animal is proposed.

1,420 **APPARENT MOTION OF A FIXED LUMINOUS TARGET DURING SUBGRAVITY TRAJECTORIES**
Schock, G. J. D.
February, 1958
Air Force Missile Development Center
Holloman Air Force Base, N. M.
AFMDC-TN-58-3 (ASTIA AD-135,009)

The purpose of this study was to determine the effects of linear acceleration and deceleration found in flying a ballistic trajectory on the visual perception of a target in the dark. Four subjects observed a fixed luminous target while the pilot of an F-94 aircraft executed the ballistic trajectory.

During increased forward acceleration and vertical-*g* force, the target appeared to move downward. The reverse occurred with deceleration and decreased vertical-*g*-force values. During weightlessness the target appeared to stabilize and oscillate up and down as the subject made excursions into negative *g* and positive subgravity states, respectively.

1,421 REVIEW OF IGY UPPER AIR RESULTS
Kellogg, W. W.
June 5, 1959
RAND Corp., Santa Monica, California
P-1717

The purposes of this review are: to partially document the work which has been done in so many different places, so that one can see what results have been published; and to seek new insight into the everchanging patterns in the atmosphere, which can usually only be done by comparing various different observations.

1,422 PROBLEMS OF SATELLITES AND SPACE OPERATIONS
April–July, 1958
Office of Naval Research
Washington, D. C.
ONR-4

This is a group of eight papers on space problems and what is being done to solve them. The titles of the papers are: "Problems of the Space Age"; "Some Objectives of Space Research"; "Space Navigation and Celestial Mechanics"; "Satellite Tracking"; "Satellite Payload Optimization"; "Astronomy and Space Operations"; "Space Communications"; and the "National Aeronautics and Space Administration."

1,423 A TECHNIQUE FOR INSTRUMENTING SUBGRAVITY FLIGHTS
Schock, G. J. D., and Simons, D. G.
February, 1958
Air Force Missile Development Center
Holloman Air Force Base, N. M.
AFMDC-TN-58-4 (ASTIA AD-135,008)

The equipment designed to instrument subgravity flights is simple and has the advantage of being light and compact. The complete package weighs less than 15 lb and can be fitted easily into the observer's compartment in an F-94C aircraft.

Some of the more interesting facts of recent flights have been an incident of extreme vertigo and disorientation of a pilot with more than 3,000 flying hours, observations on the behavior of different fluids under subgravity and zero-gravity conditions, and a high incidence of motion sickness. Preliminary experiments indicate that a study of fluid behavior under extended periods of true zero *g* will be worthwhile for planning and designing future space vehicles.

1,424 **SEMINAR OF ASTRONAUTICS AND SPACE SCIENCES, ROME, MAY 18–29, 1959**
Summaries of the Lectures
University of Rome, School of Aeronautical Engineering, Italy

Titles of the papers summarized and their authors are:

"The Impact of Space Technology on Technical Education, Governmental Procedures and on Industry in the United States"
Perkins, C. D., Princeton University, N.J.

"One Problem of Aeronautical Medicine in the Space Sciences" (in Italian) Barr, N. L., Corpo di Sanitá Marina Militar, S.U.

"Astronomical Orbits and Orbits of Artificial Satellites" (in Italian)
Sconzo, P., Universita di Roma, Universita di la Plata

"Importance of the Sun in the Question of Space Physics" (in Italian)
Fortini, L., Osservatorio Astronomico di Roma

"Guidance for Space Missions"
Pfeiffer, C. C., Jet Propulsion Laboratory, California Institute of Technology, Pasadena

"The Characteristics of the Atmosphere"
Vassy, E., University of Paris

"Communication System Problems in the S-Plane"
Lorens, C. S., Jet Propulsion Laboratory, California Institute of Technology, Pasadena

"Structural and Thermal Problems for Astronautics Vehicles"
Broglio, S., University of Rome

"Materials for Astronautic Vehicles"
Murphey, A. J., College of Aeronautics, Cranfield, England

"Aerodynamics at Low Density"
Charwat, A. F., University of California

"Conferences on the Aerothermics in Astronautics"
Brun, A. E., University of Paris

"Hypersonic Aerodynamics"
Malavard, L., University of Paris

"Spacecraft Propulsion"
Rothrock, A. M., National Aeronautics and Space Administration, Washington, D.C.

"Present and Future Accomplishments and Trends in Space Activities"
Rothrock, A. M., National Aeronautics and Space Administration, Washington, D.C.

1,425 THE STATUS AND IMPROVEMENT OF PHYSICAL CONSTANTS NEEDED FOR PRECISION TRAJECTORIES
Herrick, S.
December 1, 1958
RAND Corp., Santa Monica, Calif.
P-1559

Intercontinental trajectories of the highest precision require accurate knowledge of: the geocentric gravitational constant, k_e; the coefficients of the second and fourth harmonics, J and K, in the gravitational field of the spheroid that best represents the earth; the equatorial radius and flattening thereof, a_e and f; and the "local anomalies" or departures of the "geoid" from the spheroid, both geodetic and gravitational. These data enter, in part, in the equations of motion determining the trajectory and, in part, in the survey information regarding the point of departure and the target. Both aspects require further accurate knowledge of an inertial reference framework and the rotation of a terrestrial framework with respect to it. Take-off and landing require knowledge of the constants specifying the aerodynamic forces on the vehicles, of course, together with those that define a standard atmosphere. Meteorology is called upon to recognize departure from the standard atmosphere as it affects not only drag but also electronic and optical observations made to improve knowledge of the actual trajectory.

1,426 SPACE FLIGHT GROUND FACILITY REQUIREMENTS PROBLEMS—LAUNCHING FACILITIES
O'Sullivan, J. J.
February 24, 1958
RAND Corp., Santa Monica, Calif.
P-1431

This lecture discusses launching facilities for large rockets, such as those that will be required for space flight. The need for early and continued cooperation between designers of the rockets and designers of ground-handling equipment is stressed.

1,427 SATELLITE WEATHER RECONNAISSANCE
Greenfield, S. M., and Kellogg, W. W.
June 12, 1958
RAND Corp., Santa Monica, Calif.
P-1402

Various aspects of weather reconnaissance by satellites–including limitations, capabilities relative to present methods, and growth potential are discussed.

1,428 DISCONTINUED

1,429 **SOME GENERAL CONCEPTS OF DYNAMICS AND THEIR APPLICATION TO THE RESTRICTED THREE-BODY PROBLEM**
Lagerstrom, P. A., and Graham, M. E.
December, 1958
Douglas Aircraft Corp., Santa Monica, Calif.
Report SM-23401

This report was prepared from a series of lectures given by P. A. Lagerstrom at Douglas Santa Monica in the summer of 1958. Kinematics is reviewed with special attention given to coordinate transformations. Conservation theorems and Lagrange's and Hamilton's equations of motion are discussed and illustrated by simple examples. Integrals of motion of the two-body problem are found and with their aid the two-body problem is reduced to two uncoupled central-force problems. The general three-body problem is formulated and integrals of motion found. Lagrange's special solutions are discussed. Finally the restricted three-body problem (third body of negligible mass as compared to the masses of the first two bodies) is formulated under the assumption that the two bodies of non-negligible mass each move in circles about their common center of gravity. It is shown that, in a rotating system of coordinates which brings these first two bodies to rest, the energy (kinetic, plus gravitational, plus centrifugal) of the third body is conserved. The use of this energy integral is discussed at length.

1,430 SATELLITE PERTURBATIONS RESULTING FROM LUNAR AND SOLAR GRAVITATIONAL EFFECTS
Levin, E.
December 1, 1958
RAND Corp., Santa Monica, Calif.
P-1561

The perturbations of a near-circular earth satellite orbit by the gravitational attraction of the sun or the moon may be determined by using relatively simple mathematical techniques. The results are in agreement with those obtained by more elaborate and somewhat less familiar methods used in celestial mechanics.

1,431 ATMOSPHERIC PERTURBATIONS OF ARTIFICIAL SATELLITES
Leeper, E.
September 24, 1958
RAND Corp., Santa Monica, Calif.
P-1496

The purpose of this paper is to present straightforward and accurate methods of computing drag perturbations, with corrections for influencing factors such as the rotation of the earth. Preliminary considerations and basic ideas as well as the mathematical formulas are given for this type of computation.

1,432 CALIBRATING THE MARK II MINITRACK SYSTEM WITH RADIO STARS AS SIGNAL SOURCES
Simas, V. R, and Kronmiller, G. C., Jr.
October 17, 1958
Naval Research Laboratory, Washington, D.C.
NRL Report 5215

The Mark II Minitrack system is described briefly and an operational analysis is made. A means of external calibration of the system by tracking radio stars is described and illustrated. Results obtained by this method are presented and compared with results obtained by the complex but more precise method used in calibrating prime minitrack status. It is shown that the tracking of radio stars does, in fact, provide an adequate system calibration if sufficient data are taken.

1,433 COSMIC TERRESTRIAL RELATIONS
Kallman, H. K.
November 20, 1958
RAND Corp., Santa Monica, Calif.
P-1553

The present concept of the universe and earth's place in it is discussed. Temperature, composition, age, origin, development, and radiation are the prime concerns of this report.

1,434 LINES OF FORCE OF THE GEOMAGNETIC FIELD IN SPACE
Vestine, E. H., and Sibley, W. L.
November 7, 1958
RAND Corp., Santa Monica, Calif.
P-1541

The lines of force of the geomagnetic field at various latitudes and longitudes in the northern hemisphere are traced approximately to their intersections with the earth's surface in the southern hemisphere, using an electronic computer and the first nine gauss coefficients. Those lines leaving the average northern auroral zone are traced to their intersection of the geomagnetic field with the earth's surface. These points of intersection are found to be very nearly at the average southern auroral zone deduced from auroral observations, and from magnetic measurements of disturbance. It is concluded, therefore, that the geomagnetic field has stability and a simple character even at distances as great as about six earth radii above the earth, measured in the equatorial plane, even during auroral displays. It is also concluded that solar streams at such times do not seriously distort the field lines connecting the auroral zones.

1,435 LUNAR RAYS: THEIR FORMATION AND AGE
Giamboni, L. A.
June 20, 1958
RAND Corp., Santa Monica, Calif.
P-1409

The nature of the rays of Tycho and Copernicus suggests that they were laid down at a time when the angular velocity of the moon was markedly different from that observed today. The rays of Tycho indicate that the lunar siderial period was between 0.5 and 6.8 days, and that the poles were in approximately the same position then as today. These rays were created within 8×10^7 years of the time the moon was formed. The rays of Copernicus support these observations and indicate that the rotation of the moon at the time these rays were formed was similar to the rotation which existed at the time Tycho was formed.

1,436 ENVIRONMENTAL REQUIREMENTS FOR EXTENDED OCCUPANCY OF MANNED SATELLITES
Dole, S. H.
December 12, 1958
RAND Corp., Santa Monica, Calif.
P-1577

The environmental conditions that must be maintained within a manned space craft are analyzed thoroughly in this report. Charts showing the tolerable limits of stress, pressure, oxygen, CO_2 content, acceleration forces, temperature and humidity, and radiation are given. The conclusion is drawn that if conditions are kept within these stated limits man could survive, physiologically, in space. The psychological problems of space flight are not presented in this report.

1,437 MULTIPLE IMAGE PRINTING FOR PLANETARY PHOTOGRAPHY
Kirby, D. S.
July 25, 1958
RAND Corp., Santa Monica, Calif.
P-1446

The process of multiple image printing for the purpose of getting finer details in planetary photographs is explained. The method is to superimpose several short exposures until more detail is obtained.

1,438 ON LUNAR AND PLANETARY EXPERIMENTS
Greenfield, S. M.
October 29, 1958
RAND Corp., Santa Monica, Calif.
P-1535

At the second meeting of the Lunar and Planetary Exploration Colloquium an attempt was made to produce a list of possible experiments that could be conducted in connection with exploring the moon and possibly the planets. The subject of contamination of the area being explored and its effect on the validity of the experiments was considered.

1,439 **OUTLINE OF A STUDY OF EXTRATERRESTRIAL BASE DESIGN**
Holbrook, R. D.
April 22, 1958
RAND Corp., Santa Monica, Calif.
RM 2161 (ASTIA AD-156,043)

Requirements for extraterrestrial bases of various types and of the effect of design requirements on associated space flight systems are presented.

In the context of the example, i.e., the design for a lunar base, a review is presented of the state of our knowledge of the moon, of rocket transport problems, and of experiments which should precede establishment of a lunar base. Discussions are also given of ecological problems, base and support system design, component hardware, and planning for major activities. The growth of initial facilities by utilization of local materials, which is the essential problem of colonization, is also considered. The outline concludes with a listing of specific study topics for a research program, and a selective bibliography.

1,440 **ORBIT AND SPACE TRAJECTORY DETERMINATION**
Speer, F. A., Miner, W., Yarbrough, T. C., and Lundquist, C. A.
June 3, 1959
Army Ballistic Missile Agency, Huntsville, Ala.
Report DIR-TR-1-59

Five papers were given at the NASA conference on Orbit and Space Trajectory Determination held on March 12, 13, and 14, 1959. These papers include: the present State of Orbit Determination at ABMA; Vari-centric Method of Calculation of Lunar and Space Probe Trajectories; Characteristics of Computational Programs Used by ABMA; and some research problems considered at ABMA concerning satellite and probe orbits.

1,441 **RESEARCH IN SPACE SCIENCE**
Catalogue of Satellite Observations for March and April, 1959
Albert, R. G., and Adams, R. M.
May 21, 1959
Smithsonian Institution, Cambridge, Mass.
Astrophysical Observatory
Special Report 26

This catalogue contains all artificial earth satellite observations for March and April 1959 which were received by the Smithsonian Astrophysical Observatory. Doppler and Minitrack are not included. The Satellite Vehicles tracked during this period are: Explorers I and IV, Sputnik III, and Vanguard I, II, and the Vanguard II rocket.

1,442 FLOW THEORY DEVELOPMENT FOR A CRYOGENIC LIQUID
Spieth, C. W., Corbett, R. J., Killian, W. R., and Pope, D. H.
September, 1958
Beechcraft Research and Development, Inc., Wright Air Development Center, Wright-Patterson AFB, Ohio
WADC TR-58-529

The use of SF-1 as a fuel for a space vehicle will require a test-proven transfer design method for the lines connecting the components of the propulsion system. The objective of this report will be to provide the propulsion system engineer with the required test data, theoretical study, and design methods. If the design methods are properly applied, functional and economical, SF-1 transfer lines can be obtained.

This report provides a theoretical approach to single-phase flow with a discussion of the thermal and frictional factors involved. The test apparatus is described and the raw data obtained from the test program are presented. The theoretical approach and the experimental data have been compared and the relationships correlated.

1,443 FIRST SEMIANNUAL REPORT TO THE CONGRESS BY THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
June 16, 1959
National Aeronautics and Space Administration, Washington, D.C.

This report describes the events surrounding the creation of the National Aeronautics and Space Administration. The Space Act of 1958 is defined and NASA's efforts to comply with the provisions of the Act are reported. Accounts are given of the preparations and results of the programs under NASA's direction.

1,444 FLIGHT EXPERIMENTS ABOUT HUMAN REACTIONS TO ACCELERATIONS WHICH ARE FOLLOWED OR PRECEDED BY THE WEIGHTLESS STATE
Von Beckh, H. J.
December, 1958
Air Force Missile Development Center
Holloman Air Force Base, N.M.
AFMDC-TN-58-15 (ASTIA AD-154,108)

The author conducted flight experiments in jet aircraft, which simulated "pre-weightlessness" and "post-weightlessness" accelerations.

It was shown that alternations of acceleration and the weightless state decrease the acceleration tolerance of the subject and the efficiency of the physiological recovery mechanisms.

The implications for planning of manned space flight are, first, thrust values and re-entry profiles must take the lower acceleration-tolerance into consideration; and second, that adequate g-protection must be designed for the pilot to prevent dangerous effects of unavoidable high accelerations.

1,445 **HEARINGS BEFORE THE SUBCOMMITTEE ON GOVERNMENTAL ORGANIZATION FOR SPACE ACTIVITIES OF THE COMMITTEE ON AERONAUTICAL AND SPACE SCIENCES, UNITED STATES SENATE**
United States Congress
86th, First Session
March 24, 26, and April 14, 15, 22-24, 29, and May 7, 1959
United States Government Printing Office
Washington, D.C.

A thorough review of the governmental organization is given for all phases of space research, including the military.

1,446 **BIBLIOGRAPHY OF SPACE MEDICINE**
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U.S. Department of Health, Education, and Welfare;
Public Health Service, Washington, D.C.
Bibliography Series No. 21
Publication 617

The references for this bibliography were selected from the indexes and catalogs of the National Library of Medicine and from the principal aviation, aviation medicine, and astronautical publications.

1,447 **PAPERS FROM 30TH ANNUAL MEETING, AERO MEDICAL ASSOCIATION (Held at the Statler Hilton Hotel, Los Angeles, Calif.)**
April 27–29, 1959
Aero Medical Association, Washington, D.C.

Titles of the papers summarized and their authors are:

"The Effect of Glycine Administration in a Human Response to a Standardized Cold Stress"
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Arctic Aeromedical Laboratory, Ladd AFB, Alaska

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Ades, W.
USN School of Aviation Medicine, Pensacola, Fla.

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Agen, H. E.
USA Quartermaster Research and Engineering Command, Natick, Mass.,
Dray, W.
Pioneer-Central Division, Bendix Aviation Corp., Davenport, Ia.

"Factorial Structure and Validity of Naval Aviation Selector Variables"
Ambler, R. K., Bair, J. T., Wherr, R. J. Jr.
USN School of Aviation Medicine, Pensacola, Fla.

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Bair, J. T.
USN School of Aviation Medicine, Pensacola, Fla.

"Problems Involved in Providing Protection for Aircrewman During Escape"
Beck, A. I., and Cooper, B.
Republic Aviation Corp., Farmingdale, N.Y.

"Discussion of the Abnormal Stresses Imposed on the Pilot During the Manhigh III Balloon Flight. I. Psychological Data and Other Factors Contributing to this Stress"
Beeding, E. L., and McClure, C. M.
Aero Medical Field Laboratory, Holloman, N.M.

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Aero Medical Field Laboratory, Holloman, N.M.

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Benson, A. J.
Institute of Aviation Medicine, Farnborough, England

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Berkshire, J. R.
USN School of Aviation Medicine, Pensacola, Fla.

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Berman, M. L.
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Sierra Engineering Co., Sierra Madre, Calif.

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"An Experiment in Prolonged Vigilance"
Wherry, R. J. Jr.
USN School of Aviation Medicine, Pensacola, Fla.

"Experimental Studies of the Effects of Accelerative Stress on Visual Performance"
White, W. J.
Cornell Aeronautical Laboratory, Buffalo, N.Y.

"Modified Diluter-Demand Breathing Valve"
Wilcox, O. W.
Sierra Engineering Co., Sierra Madre, Calif.

"The Identification of Future Failures Among Marginal Disciplinary Cases"
Willingham, W. W.
USN School of Aviation Medicine, Pensacola, Fla.

"Comparison of Hearing Loss of Personnel Exposed and Not Exposed to High Intensity Sound"
Willis, S. K., Hoffman, I. L.
Westover AFB, Mass.

"Medical Problems in High Altitude Suit Testing"
Wilson, C. L., and Zinn, M. B.
Aero Medical Laboratory, Wright-Patterson AFB, Ohio

1,448 **OBSERVATIONS OF LOW ENERGY SOLAR COSMIC RAYS FROM THE FLARE OF 22 AUGUST, 1958**
Anderson, K. A., Arnoldy, R., Hoffman, R., Peterson, L., and Winckler, J. R.
State University of Iowa
SUI-59-9

Observations have been made of protons at balloon altitudes in the energy range 100 to 300 Mev following a solar sequence of optical flare, rf noise bursts and long enduring noise storm. Other particles are shown to have low upper limits to their abundance. The flare particles continue to be observed for at least two days and arguments are given to show that their storage and emission takes place in the solar atmosphere. The differential energy spectrum is derived from ionization vs atmospheric depth data and is found to be $E^{-5}\,dE$. Observations by riometer and VHF scatter propagation paths over the polar regions indicate that solar acceleration of protons up to roughly 100 Mev energy is rather frequent.

1,449 **PROCEEDINGS OF LUNAR AND PLANETARY EXPLORATION COLLOQUIUM**
January 12, 1959
North American Aviation, Inc., Los Angeles, Calif.
Vol. 1, No. 4

The following papers were given and discussed:

"Geochemical Implications of Lunar Degassing"
Green, J., California Research Corp.

"The Alphonsus Story"
Alter, D., Griffith Observatory

"High Velocity Impact Studies"
Scully, C. N., Aero/Space Laboratories, NAA

"Sonic Velocity in Possible Lunar Surface Materials"
Green, J., California Research Corp.

"The Problem of the Martian Blue Haze"
Wilson, A. G., RAND Corp.

"Comparison of Lunar and Martian Features"
Tombaugh, C., State College, New Mexico

"Results of Pioneer I Flight"
Sonett, C. P., Space Technology Laboratories, Inc.

"Results of Pioneer III Flight"
Hibbs, A. R., Snyder, C. W., Jet Propulsion Laboratory, California Institute of Technology, Pasadena

1,450 **WATER-LANDING CHARACTERISTICS OF A RE-ENTRY CAPSULE**
McGehee, J. R., Hathaway, M. E., and Vaughan, V. L., Jr.
June, 1959
National Aeronautics and Space Administration, Langley Research Center, Langley Field, Va.
NASA Memo 5-23-59L

Experimental and theoretical investigations have been made to determine the water-landing characteristics of a conical-shaped re-entry capsule having a segment of a sphere as the bottom. For the experimental portion of the investigation, a 1/12-scale model capsule and a full-size capsule were tested for nominal flight paths of 65° and 90° (vertical), a range of contact attitudes from −30° to 30°, and a full-scale vertical velocity of 30 ft/sec at contact. Accelerations were measured by accelerometers installed at the centers of gravity of the model and full-scale capsules. For the model test, the accelerations were measured along the X-axis (roll) and Z-axis (yaw) and for the full-scale test they were measured along the X-axis (roll), Y-axis (pitch), and Z-axis (yaw). Motions and displacements of the capsules that occurred after contact were determined from high-speed motion pictures. The theoretical investigation was conducted to determine the accelerations that might occur along the X-axis when the capsule contacted the water from a 90° flight path at a 0° attitude. Assuming a rigid body, computations were made from equations obtained by utilizing the principle of the conservation of momentum. The agreement among data obtained from the model test, the full-scale test, and the theory was very good. The accelerations along the X-axis for a vertical flight path and 0° attitude, were in the order of 40g. For a 65° flight path and 0° attitude, the accelerations along the X-axis were in the order of 50g. Changes in contact attitude, in either the positive or negative direction from 0° attitude, considerably reduced the magnitude of the accelerations measured along the X-axis. Accelerations measured along the Y- and Z-axis were relatively small at all test conditions.

1,451 **THE EFFECT OF EXPOSURE TO SIMULATED HIGH ALTITUDES ON ANAPHYLAXIS IN MICE**
Harris, W. E., and Fulton, J. D.
January, 1958
Air Force School of Aviation Medicine, Randolph AFB, Texas
58-42

A study was made of the way acute and prolonged exposure to simulated high altitude affects anaphylaxis in mice. Mortality at 15 min and at 4 hr after challenge was found to be higher in groups of mice exposed to 20,000 ft altitude than in comparable groups treated at ground level. Hematocrit change in anaphylactic mice exposed to 20,000 ft did not differ significantly from that in mice treated at ground level. In mice maintained at a 15,000 ft simulated altitude for 15 days, neither hematocrit change nor mortality following challenge was significantly different from that of mice treated at ground level.

1,452 ALTITUDE EXPOSURE AND INTRA-AORTIC INFUSION OF NORADRENALIN IN THE DOG

Vawter, G. and Wayne, H. H.
February, 1958
Air Force School of Aviation Medicine, Randolph AFB, Texas
58-30

Noradrenalin sufficient to elevate mean femoral arterial pressure to 18 mm Hg was continuously infused into the ascending aorta of 8 dogs for 15 min at ground level, during ascent to altitude, and for 55 min at 34,000 ft. Seven experiments with infusion of saline under similar conditions provided control data. All dogs were supine and were maintained under pentobarbital anesthesia.

Three experiments terminated prematurely with infusion of noradrenalin after exposure to altitude. No delayed mortality or neurologic sequelae were recognized. Some degree of hypoxia existed, at least for short periods in most cases. Clotting times and sedimentation rates decreased whereas hematocrits increased earlier and more conspicuously with infusion of noradrenalin than with infusion of saline. Autopsies on eight dogs demonstrated one or more infarctlike lesions in 7 dogs, 6 of which survived until sacrifice 24 to 48 hr after exposure.

These results are discussed in relation to the intrinsic nature of the exposure and to the results of previous experiments of similar nature.

1,453 LATENT EFFECTS OF CHRONIC WHOLE-BODY IRRADIATION OF MONKEYS WITH MIXED SOURCE RADIATION

Davis, R. T., Elam, C.B., and McDowell, A. A.
February, 1958
Air Force School of Aviation Medicine, Randolph AFB, Texas
57-59

Monkeys were studied on learning tasks given 5½ months before, 7½ months during, and 13½ months after chronic mixed source irradiation. The results indicated no significant dose response in learning tasks. A syndrome of changes was noted: (1) irradiated animals had significantly different food preferences from the controls; (2) animals receiving the higher radiation doses showed stronger preferences for food in lower spatial quadrants than did control and lower dose group animals; (3) irradiated animals made more cage-directed, but fewer rapid-energy response than did control group animals; (4) control animals were more distracted by extraneous sounds, both in the free cage and under formal laboratory task situations.

1,454 A COMPARISON OF NORMAL AND IRRADIATED MONKEYS ON AN ODDITY-REVERSAL PROBLEM
McDowell, A. A, and Brown, W. L.
April, 1958
Air Force School of Aviation Medicine, Randolph AFB, Texas
58-73

Normal, low-dose irradiated, and high-dose irradiated monkeys were tested on an oddity-reversal problem which used the same stimulus cues in antagonistic response patterns. Originally, each animal was tested 24 trials a day to the criterion of two successive days with two errors or fewer a day on response to the object which was odd in color. In reversal training, each animal was tested to the same criterion on response to the object which was odd in form.

Among the groups, no consistent differences were observed in the number of errors made in reaching either the pre- or postreversal criterion. All groups showed a statistically significant increase in errors to criterion on reversal learning over errors to criterion on original learning. There was a statistically significant difference in negative saving scores, indicating the superiority of the irradiated animals over the normal animal with respect to reversal problems of this type.

1,455 BIBLIOGRAPHY ON METEORITIC DUST WITH BRIEF ABSTRACTS
Hoffleit, D.
1952
Harvard College Observatory, Cambridge, Mass.
Harvard Reprint Series II-43
(ASTIA AD-5639)

A bibliography on meteoritic dust and closely allied topics, consisting of some 500 references, has been compiled from sources available at Harvard Observatory. For most of the references an abstract of a sentence or two has been added to enhance their usefulness. The nucleus of the bibliography was a card catalogue prepared twenty years ago by the late Willard J. Fisher. Arrangement of the bibliography is by senior author rather than by subject or date.

1,456 THE UPPER BOUNDARY OF THE VAN ALLEN RADIATION BELTS
Snyder, C. W.
June 19, 1959
Jet Propulsion Laboratory, California Institute of Technology, Pasadena
Section Report 22-5

Measurements of the cosmic-ray intensity above the earth's upper radiation belt by Mechta and Pioneers III and IV seem to disagree by almost a factor of 2.

This report discusses the resolution of this discrepancy and some new data bearing on the spatial extent of the trapped radiation.

The data from Pioneer IV showed a constant rate of 1.09 counts/sec beyond a range of 91,000 km (measured from the center of the Earth).

Pioneer III never reached a region where the counting rate ceased to vary with altitude. When contact with the probe was lost, the counting rate had dropped to only 2.25 counts/sec and appeared to be still dropping at approximately 0.01 counts/sec per 1000 km.

The assumptions that the 2.25 counts/sec rate was near the asymptotic value and that the trapped radiation contributed negligibly to the counting rate are shown in this report to be invalid. Actually, the counting rate dropped considerably lower. This report offers a new explanation of the data obtained from these space probes.

1,457 INTERPLANETARY POST-INJECTION GUIDANCE
Noton, M.
June 4, 1959
Jet Propulsion Laboratory, California Institute of Technology, Pasadena
External Publication 653

This report considers several systems of mid-course and terminal guidance (post-injection systems) that might be applied to interplanetary missions in the next five years. The necessary theoretical background is developed for the formation of guidance equations and for carrying out error analyses.

Mid-course guidance both by radio command and with a celestial navigator is discussed, and error-analyses for special cases are presented. The over-all accuracy of a radio-command system is estimated, and representative figures are derived to illustrate the goal of hardware development for celestial navigators. Terminal guidance prior to entry into planetary atmospheres is similarly discussed.

1,458 SATELLITE MOTION ABOUT AN UNSYMMETRICAL BODY
Lass, H., and Lorell, J.
May 20, 1959
Jet Propulsion Laboratory, California Institute of Technology Pasadena
External Publication 646

The motion of a satellite is obtained in explicit closed form by applying the nonlinear technique of Kryloff–Bogoliuboff. It is shown that if a perturbing mass is close to the principal center of force, the motion of the satellite remains essentially elliptic.

1,459 SELECTED ITEMS ON SOVIET ASTRONOMY
Gnevyshev, M. N., Chekirda, A. T., and Podobed, V. V.
January 13, 1959
U. S. Joint Publications Research Service
New York
JPRS/DC-448

This report contains three articles by Russian scientists which indicate to some extent the type of research being done in the USSR in the field of astronomy. Advanced education facilities, observation programs, conferences, and instrumentation of the facilities are some of the subjects mentioned.

1,460 NASA AUTHORIZATION FOR FISCAL YEAR 1960
(Hearings before the NASA Authorization
Subcommittee of the Committee on Aeronautical and
Space Sciences, United States Senate. Part I: Scientific
and Technical Presentation)
U. S. Congress
86th, First Session
April 7-10, 1959
United States Government Printing Office,
Washington, D. C.

The papers presented and their authors were as follows:

"Atmospheric Entry of Ballistic Missiles"
Allen, J. H.

"Missile Problems and Their Solutions"
Ames, M. B., Jr.

"Structures for Hypersonic Vehicles"
Anderson, R. A.

"Project Centaur"
Appold, N. C.

"Project Snap and Project Rover"
Armstrong, J. L.

"Materials"
Ault, G. M.

"Manned Hypersonic Vehicles"
Becker, J. V.

"Vertical Takeoff and Landing Aircraft"
Campbell, J. P.

"Entry into Planetary Atmospheres"
Chapman, D. R.

"Electric Rockets"
Childs, J. H.

"Ionospheres"
Clark, J. F.

"Insertion Guidance for Satellites"
Clayborne, J. P.

"Meteorological Satellites"
Cortright, E. M.

"TIROS Meteorological Satellite; Advanced Lunar and Planetary Exploration"
Crocker, J. A.

"Piloting and Control of Manned Hypersonic Vehicles"
Drake, H. M.

"Electrical Power in Space"
English, R. E.

"Project Mercury System"
Faget, M. A.

"Magnetic, Electronic, and Gravitational Fields"
Fellows, R. F.

"Space Capabilities of Nuclear Rockets"
Finger, H. B.

"Current Biomedical Programs"
Flickinger, D. D.

"NASA Authorization Request for Fiscal Year 1960"
Glennan, T. K.

"Launching and Insertion Facilities"
Hagen, J. P.

"Space Structures"
Heldenfels, R. R.

"Structural Dynamics"
Houbolt, J. C.

"Noise"
Hubbard, H. H.

"Advanced Technology"
Hyatt, A.

"Communication Satellite Systems"
Jaffe, L.

"Space Communications; Manned Space Flight"
Low, G. M.

"Chemical Air-breathing Propulsion Systems"
Lundin, B. T.

"Project Mercury Operations"
Mathews, C. W.

"Communication and Computing Systems"
Mengel, J. T.

"Energetic Particles"
Meredith, L. H.

"Geodetic and Navigational Satellites"
Milwitzky, B.

"Midcourse and Terminal Guidance; Space Propulsion Requirements"
Moeckel, W. E.

"Atmospheres"
Newell, H. E., Jr.

"Astronomy"
O'Keefe, J. A.

"Geodetic Discrepancies; Advanced Flight Development"
Rhode, R. V.

"Project VEGA"
Rosen, M. W.

"Tracking and Data Collection Instrumentation"
Smith, F. B.

"Space Sciences Research Vehicles and Programming"
Stoller, M. J.

"Interceptor Missiles"
Stone, D. G.

"Project Scout"
Stoney, W. E., Jr.

"1½ Million Pound Thrust Single Chamber Rocket Engine"
Tischler, A. O.

"Meteorological Considerations"
Wexler, H.

"X-15 Research Airplane Project"
Williams, W. C.

"Aerodynamic Problems of Supersonic Cruise Aircraft"
Wilson, H. A.

"Nuclear Propulsion for Air-breathing Engines"
Woodward, W. H.

"Advanced Biomedical Programs"
Worf, D. L.

1,461 ON THE POSSIBLE USES OF MANNED SPACE FLIGHT CAPABILITY FOR ENGINEERING RESEARCH
Stewart, H. J.
1959
Jet Propulsion Laboratory, California Institute of Technology, Pasadena
External Publication 489

Considerations for building a manned space station are given. A brief summary is made of the problems involved vs the knowledge to be gained.

1,462 THE GEOMAGNETICALLY TRAPPED CORPUSCULAR RADIATION
Van Allen, J. A.
June, 1959
Department of Physics, University of Iowa
SUI-59-16

The satellites and probes which provided the information for this report are mentioned. The nature of the trapped radiation and some views on its origin are discussed. Variations in radiation intensity and zone boundaries at different times of observation are shown to be of value in determining the origin of the outer zone. The possibility of similar radiation belts existing around the moon and other planets is considered.

1,463 1958 NASA/USAF SPACE PROBES (ABLE—I)
February 18, 1959
Space Technology Laboratories, Los Angeles, Calif.
AFBMD-TR-59-1 (I, II, and III)
(ASTIA AD-211820-211821-211822)

Volume I of this report is a summary of the 1958 NASA/USAF Space Probe (ABLE—I) program as a whole.

Volume II concerns the payload and the experiments conducted during this program.

Volume III describes the booster vehicles, trajectories, and flight histories.

1,464 INSTITUTE OF THE AERONAUTICAL SCIENCES
27th Annual Meeting in New York
January 26–29, 1959
Papers 59/1-82

Papers presented dealing with subjects in the field of astronautics are listed with paper numbers, title, author and author's place of business as follows:

59-9 "Proposed Observations of the Martian Atmosphere"
Ross, M. D., Office of Naval Research

59-10 "Self-Contained Electric-Hydraulic Accessory Power Unit"
McManus, R. L., General Electric Co.

59-13 "The Physicists' Viewpoint: The Function of Universities in the Aero-Space Engineering Education"
Singer, S. F., University of Maryland

59-15 "Industry's Viewpoint on the Challenge of Space Technology to Aeronautical Engineering"
Merrill, G., Fairchild Engine and Airplane Corp.

59-22 "Viability Surveillance and Data Collection in Biosatellite Experiments"
Hetherington, A. W., Air Research and Development Command

59-24 "Potentialities and Problems of Nuclear Rocket Propulsion"
Cotter, T. P., Los Alamos Scientific Laboratory

59-25 "Performances of Nuclear Electric Propulsion Systems"
Kovacik, V. P., Ross, D. P., Thompson Ramo-Wooldridge Inc.

59-29 "Geophysical Researches with the Stratospheric Laboratory"
Roberts, W. O., Newkirk, G., Jr., University of Colorado

59-30 "Guidance Requirements of Ballistic Satellites"
Stateman, M. J., Arma Division, American Bosch Arma Corp.

59-31 "The Determination of Round-Trip Planetary Reconnaissance Trajectories"
Battin, R. H., Massachusetts Institute of Technology

59-32 "Design of Automatic Flight Control Systems for Manned Space Vehicles"
Kelly, A. J., United States Navy

59-33 "Inertial Guidance for Hypersonic and Orbital Vehicles"
Johnson, G. W., MacDonald, R. B., IBM Corp.

59-34 Wave Propagation Through Ionized Gas in Space Communications"
Fischer, F. J.

59-39 "Studies of Pilot Control During Launching and Re-entry of Space Vehicles, Utilizing the Human Centrifuge"
Woodling, C. H., Clark, C. C.

59-40 "Systems Using Solar Energy for Auxiliary Space Vehicle Power"
Von Doenhoff, A. E. and Hallissy, J. M., Jr., NASA

59-41 "The Problem of Escape from Satellite Vehicles"
Carter, C. V., and Huff, W. W., Jr., Chance Vought Aircraft, Inc.

59-45 "Cosmic Ray Detection by Visual Scintillations"
Yagoda, H., Air Force Cambridge Research Center

59-46 "The Balloon-Borne Capsule as a Space Flight Trainer"
Beson, E. E., General Mills, Inc.

59-47 "Infra-Red Spectroscopy from Balloons and the Possibility of Some Observations on the Biosphere"
Gates, D. M., National Bureau of Standards

59-48 "The Strato-Laboratory as a Systems Testing Platform"
Smith, J. R., Raven Industries, Inc.

59-51 "Man-Machine Integration in Space Vehicles"
Hoover, G. W., Office of Naval Research

59-52 "Implications of Space Radiations in Manned Space Flight"
Langham, W. H., University of California

59-73 "Requirements of High-resolution Photography of the Planets"
de Vaucouleurs, G., Harvard College Observatory

59-74 "An Aeronautical Engineering Educator's Viewpoint on the Challenge of Space Technology to Aeronautical Engineering Education"
Von Eschen, G. L., Ohio State University

59-80 "Some Fundamental Problems Associated with Injecting, Orbiting and Recovering a Man from Orbit"
Hakes, R. C., Northrop Aircraft, Inc.

59-81 "Training in Preparation for Man High I"
Kittinger, J. W., Jr., Wright Air Development Center

59-82 "Capabilities of Multistage Chemical Rocket Systems"
Froelich, J. E., Jet Propulsion Laboratory, California Institute of Technology, Pasadena

1,465 THE DOPPLER METHOD OF SATELLITE TRACKING
Lorens, C. S.
March 30, 1959
Jet Propulsion Laboratory, California Institute of Technology, Pasadena, Report 30 - 2

A description is presented of the theoretical development and some of the experimental results of a doppler tracking and ephemeris program for earth satellites. The tracking program uses the full doppler curves, a perturbed elliptic orbit, and a linear decay of the orbit. The theoretical development of the program is based on the minimization of the difference between the computed and the experimentally observed doppler frequency. The approach is to find a stationary point by incremental corrections based on Newton's rule for solving the partial differential equations of the error with respect to the orbital elements and the effective satellite frequency. The theoretical and experimental limitations of doppler tracking are discussed, and a detailed outline of the tracking and ephemeris program is included.

1,466 A CATALOGUE OF POSITIONAL DATA OF THE RUSSIAN ARTIFICIAL EARTH SATELLITE 1957 β
Miczaika, G. R., Ripley, W. S., and Wahl, E. W.
December 1, 1958
Air Force Cambridge Research Center, Mass., Space Flight Physics Laboratory
AFCRC TN-58-640 (ASTIA AD-213318)

This catalogue contains approximately 40,000 positional data observed during the life of the Russian earth satellite 1957 Beta. These data collected by Project Space Track are from two types of sources: those sent in by individuals and civilian organizations from all over the world, and those produced by United States Air Force facilities. The positional data are arranged chronologically, with observation station names and coordinates.

1,467 THE RADIATION DOSE IN PIONEER IV AND SHIELDING REQUIREMENTS FOR FUTURE SPACE PROBES
Snyder, C. W.
July 6, 1959
Jet Propulsion Laboratory, California Institute of Technology, Pasadena
Section Report 22-6

It is appropriate to use the data of Pioneer IV for estimating the radiation dose which might be encountered in future space missions. It seems probable that the radiation intensity in the trapped-plasma belts was unusually large because of the intense solar activity during the week preceding the flight. Unfortunately, the data are absent at the time of passage through the peak of the upper belt and are far from ideal in other respects. This report summarizes the data and gives some calculations which may be useful in designing shielding for photographic film or other components.

1,468 SUNSPOTS AND GEOMAGNETISM
Bell, B., and Glazer, H.
1958
Smithsonian Institute, Cambridge, Mass.
Astrophysical Observatory
Vol. 2, No. 8

This paper investigates the relation of geomagnetic conditions to the magnetic class, area, flare productivity, radio noise, and location of sunspots. The primary emphasis is on the magnetic class, which is found to be the optical property of sunspots most significant in relation to geomagnetic conditions, although less significant than radio noise. Magnetically complex γ sunspots appear to be the most consistently disturbing, geomagnetically, and give a marked rise in the superposed epoch Kp-curve for several days around central meridian passage. Semicomplex $\beta\gamma$ spot groups give a moderate rise in the geomagnetic index, *Kp*, while the simple unipolar α and bipolar β spots give no signficant deviation from the mean Kp. Flare productivity appears to be of moderate importance, while sunspot area is relatively unimportant. Earlier results indicating area to be significant can be reconciled with the present findings because the magnetically complex γ-spots are relatively most numerous among spot groups of very large area.

The seasonal variation in geomagnetic activity is also investigated and is shown to occur in the daily *Kp*-sums at all phases of the sunspot cycle. The axial hypothesis to explain the March and September maxima in great geomagnetic storms is not supported by the evidence. The geomagnetic activity of a sunspot appears to be independent of its location in the favorable or the unfavorable solar hemisphere. The cause of the seasonal variation in great storms remains unknown.

1,469 OBSERVATIONS ON NICKEL-BEARING COSMIC DUST COLLECTED IN THE STRATOSPHERE
Yagoda, H.
March, 1959
Air Force Cambridge Research Center, Mass.
Research Note 9
AFCRC-TN-59-200 (ASTIA AD-212,422)

Stratospheric dust particles collected on plastic surfaces have been examined microchemically for the presence of nickel using dimethylglyoxime as a specific developing reagent. Samples collected from four balloon flights with plateau elevations between 77,000 and 112,000 ft indicate the deposition of 0.17 to 0.36 nickel-bearing particles per cm^2 per day of exposure. Most of the color reactions for nickel vary between 20 and 40 microns diameter, but some dust particles as small as 1 or 2 microns have given positive reactions. Experimental details of the technique are described.

1,470 AN INTERESTING PROPAGATION EFFECT OF SPUTNIK I
Dewan, E.
December, 1958
Air Force Cambridge Research Center, Mass.
Electromagnetic Radiation Laboratory
AFCRC-TR-58-354 (ASTIA AD-160,760)

Using four 20-Mcps interferometers, the AFCRC Electromagnetic Radiation Laboratory obtained data on 35 Sputnik I passes during a period of 14 days in October 1957. A study of the data revealed anomalously peaked intensities in the signal on 4 successive days: when the satellite was between 730 and 2000 miles from the receiver, the intensity of the signal was occasionally as great as the signal received during the direct overhead pass. A theoretical model explaining the phenomenon and all its peculiarities is proposed on the basis of a quantitative analysis of both Brush recordings and the recorded audiofrequencies.

1,471 PAPERS PRESENTED AT THE ARS SEMI-ANNUAL MEETING
June 8–11, 1959
San Diego, California
American Rocket Society
New York City 36, New York

Papers presented are listed by number, title, and author as follows:

794-59 "Radio Astronomy Observations from Space"
Haddock, F. I.

795-59 "A Solar Observatory in Space"
Rense, W. A.

796-59 "Orbiting Optical Telescope"
Davis, R. J.

847-59 "Advanced Propulsion Concepts"
Fisher, E.

864-59 "Interplanetary Space Probe Auxiliary Power Systems"
Hamilton, R. C.

869-59 "Efficient Precision Orbit Computation Techniques"
Baker, R. M. L., Jr., Westrom, G. B., Hilton, C. G., *et al*

870-59 "Interplanetary Ballistic Orbits"
Karrenberg, H. K., and Arthur, P. D.

871-59 "Semi-Analytical Calculations of Orbital Perturbations of Earth Satellites"
Kozai, Y.

872-59 "Low-Thrust Takeoff from a Satellite Orbit"
Lorell, J., and Lass, H.

873-59 "The Gravitational Field of the Earth"
O'Keefe, J. A., Eckels, A., and Squires, R. K.

874-59 "Reliability of Interplanetary and Lunar Orbit Computations"
Szebehely, V. G.

879-59 "Powered Trajectory Studies for Low Thrust Space Vehicles"
Fox, R. H.

880-59 "Engineering and Scientific Problems of Ion Propulsion"
Eilenberg, S. L., and Huebner, A. L. C.

882-59 "Generation and Neutralization of Ions for Electrostatic Propulsion"
Shelton, H., Wuerker, R. F., and Sellen, J. M.

883-59 "Experimental Ion Sources for Propulsion"
Naiditch, S.

884-59 "A Pierce Gun Design for an Accelerate-Decelerate Ionic Thrust Device"
Seitz, R. N., and Raether, M. J.

1,472 **PAPERS PRESENTED AT THE ARS CONTROLLABLE SATELLITES CONFERENCE, MIT**
April 30–May 1, 1959
American Rocket Society
New York 36, N.Y.

Papers presented at the conference are listed by number, title, and author as follows:

777-59 "Terminal Guidance and Rocket Fuel Requirements for Satellite Interception"
Nason, M. L.

778-59 "Terminal Guidance for a Satellite Rendezvous"
Sears, N. E., Jr., and Felleman, P. G.

779-59 "Atmospheric Conditions at High Altitudes from Satellite Observations"
Whitney, C. A.

782-59 "The Corpuscular Radiation Environment of the Earth"
Singer, S. F.

783-59 "Application and Uses of Satellites (Some Military Applications of Controllable Satellites)"
Brady, G.

784-59 "Controlled Recovery of Non-Lifting Satellites"
Detra, R. W., Riddell, F. R., and Rose, P. H.

785-59 "The Use of Aerodynamic Lift During Entry into the Earth's Atmosphere"
Lees, L., Hartwig, F. W., and Cohen, C. B.

786-59 "Concepts Influencing the Selection of a Configuration for Atmospheric Re-entry"
Kepler, D. I.

787-59 "The Feasibility of Aerodynamic Attitude Stabilization of a Satellite Vehicle"
Wall, J. K.

789-59 "Ion Rockets for Small Satellites"
Edwards, R. N., and Brown, H.

790-59 "Rocket Systems for Satellite Attitude Control"
Sancrainte, W. A., and Schiavone, C.

791-59 "The Arc Heated Plasma Thrust Chamber"
Adams, M. C., and Camac, M.

792-59 "The Correction of Epoch Error in Circular Orbits"
Berman, L. J.

1,473 **GRAVITY TORQUE ON AN ORBITING VEHICLE**
Doolin, B. F.
1959
National Aeronautics and Space Administration
Ames Research Center, Moffett Field, Calif.
NASA TND-70

The potential energy of a small body moving under the influence of only the earth's gravity field is derived. It is shown that the effects of the earth and body oblateness are separate to terms of second order in the potential energy function. The invariance of the potential energy under orthogonal transformations is discussed and is used to simplify calculations of the terms in the potential function. The equations of the motion of the vehicle are obtained in generalized, and in body coordinates. The components of torque in body coordinates are obtained by a transformation determined by the invariance of rotational power. Two applications of the equations of motion in body coordinates are made. First it is shown that an energy integral does not exist for these equations since they are derived with respect to the satellite mass center. Then the equations are applied in simplified form to an examination of the stability of a vehicle in a circular orbit.

1,474 **SATELLITE DOPPLER MEASUREMENTS FROM SPACED LOCATIONS**
Ross, W. J.
March 31, 1959
Pennsylvania State University, University Park,
Ionosphere Research Laboratory
Quarterly Progress Report 5

Equipment and instrumentation used in observing the transmissions of 1958 $Delta_2$ is briefly described. An analysis of the data accumulated over a period of ten months is given and future plans for laboratory procedures are presented.

1,475 **AN APPROXIMATION METHOD TO COMPUTE ORBIT ROCKETS**
Koelle, H. H.
June, 1959
Picatinny Arsenal, Dover, N.J.
Feltman Research and Engineering Laboratories
Picatinny Arsenal Translation 41

An analytical method of approximation for the computation of rocket orbits is presented which makes it possible to determine, with a relatively small expenditure of time, the most important parameters of structure and performance in a multistage rocket for missions from the earth's surface to an orbit of any altitude about the earth. A simplified method for the computation of long-range rockets may also be deduced from this method. As a numerical example, a typical three-stage orbit rocket is presented.

1,476 **OBSERVATIONS OF A RELATIVISTIC SPACE TRAVELER**
Haskins, J. R.
June 1, 1959
Army Rocket and Guided Missile Agency, Huntsville, Ala.
Research Laboratory
ARGMA TR 1C31R

The question of asymmetrical aging in space travel is discussed regarding the possibility of distant clocks apparently running backward as observed by an accelerated space traveler. It is shown that this apparent backward running of clocks is consistent with apparent reabsorption of photons emitted earlier by a distant star.

1,477 **USE OF PATCHED CONICS TO DETERMINE PRE-FLIGHT INTERPLANETARY TRAJECTORIES**
Lorell, J., and Oster, C. A.
July 15, 1959
Jet Propulsion Laboratory, California Institute of Technology, Pasadena
External Publication 670

A two-conic interplanetary trajectory program, with search based on injection conditions, is described. This type of computation has certain advantages with regard to direct interpretation of engineering parameters. Use of the program is illustrated in terms of Mars trajectories.

1,478 **PAPERS PRESENTED AT THE 26TH ANNUAL MEETING, INSTITUTE OF THE AERONAUTICAL SCIENCES**
January 27-30, 1958
Institute of the Aeronautical Sciences
New York 21, New York

Papers dealing with subjects pertinent to astronautics and space technology are listed according to paper number, title, and author as follows:

794 "The Satellite Tracking Camera"
Nunn, J., Joseph Nunn and Associates

796 "The Environment of Space in Human Flight"
Berry, C. A., School of Aviation Medicine

797 "Supersonic and Hypersonic Human Flight"
Ward, J. E., Gerathewohl, S. J., and Steinkamp, G. R.

798 "Cybernetics in Human Flight"
Hauty, G. T., School of Aviation Medicine

816 "On Reducing Aerodynamic Heat Transfer Rates by Magnetohydrodynamic Techniques"
Meyer, R. C., National Advisory Committee for Aeronautics

818 "The Dynamics and Certain Aspects of Control of a Body Re-Entering the Atmosphere at High Speed"
Welch, J. D., and Shih, S. L., General Electric Co.

819 "Interrelations of Space Medicine with other Fields of Science"
Strughold, H., School of Aviation Medicine

824 "Project Far Side Launchings"
Cramer, J. L., General Mills, Inc.

828 "Booster Propulsion for Space Vehicles"
Wentink, R. S., Convair

830 "Cosmology"
Bostick, W. H., Stevens Institute of Technology

833 "The 3 Manned Stratosphere Balloon Ascents of 1957"
Winzen, O. C., Winzen Research Inc.

834 "The Role of Manned Balloons in the Exploration of Space"
Ross, M. D., and Lewis, M. L.

1,479 DESIGN TECHNIQUES FOR SPACE TELEVISION
Viterbi, A. J.
April 13, 1959
Jet Propulsion Laboratory, California Institute of Technology, Pasadena
External Publication 623

Space probes require sensors capable of functioning in extraterrestrial environments, and communications systems capable of transmitting information over extremely long ranges. In exploring other planets, a visual communications system is extremely desirable. This report describes a system for visual communications which is called a space television system. Signal levels and noise environment through which communications must be secured are determined, then the design requirements for the system are established.

An FM-PM communications system is envisioned for the dual purpose of tracking the space vehicle and telemetering the video information.

A particular discriminator design is described which shows that if the quality requirement that 8 grey levels be discernible is placed on the received image, the transmission bandwidth is limited to about 1 cps. Bandwidth compression is achieved by storing the video information on magnetic tape or photographic film and transmitting it for an arbitrary length of time. On earth, the process is reversed and an image is flashed on the screen at periodic intervals. The theory and design of the narrow-band discriminator and its effect on the over-all system design are discussed.

1,480 **METHOD OF INVESTIGATING THE IONOSPHERE USING AN ARTIFICIAL SATELLITE**
Al'pert, Ya, L.
October 27, 1958
U.S. Joint Publications Research Service, Washington, D.C.
JPRS (NY) 627

Three problems are considered in this report. The first is the study of the dependence of the electron concentration and the effective number of collisions on the altitude. The second study is the problem of the nature and causes of the statistical non-stationary character and non-uniformity of the ionosphere. The final problem concerns the study of the balance of ionization and microscopic processes in the ionosphere.

1,481 **RESULTS OF THE IGY SATELLITE PROGRAM**
Pickering, W. H.
October 13, 14, 15, 1958
Jet Propulsion Laboratory, California Institute of Technology, Pasadena
External Publication 574

Instrumentation of the Explorer Satellites is discussed. A brief description of the Microlock telemetry systems is given, as well as some results of ionization, particle, and temperature measurements in the satellite orbits.

1,482 **GUIDANCE FOR SPACE MISSIONS**
Pfeiffer, C. G.
June 12, 1959
Jet Propulsion Laboratory, California Institute of Technology, Pasadena
External Publication 656

This report discusses some of the techniques currently being employed to study the guidance problem and is concerned with missions that will be accomplished within this solar system. Emphasis is placed on guidance during propulsion. The guidance philosophy depends upon obtaining a standard trajectory, measuring deviations from this trajectory in flight, and computing the necessary correction to the path based on this information.

1,483 **ORBITAL DATA HANDLING AND PRESENTATION**
Putnam, R. E. A.
June, 1959
Ballistic Research Laboratories, Aberdeen Proving Ground, Md.
Technical Note 1265

The problem of detecting dark (passive) satellites, utilizing doppler techniques, is accompanied by a need for early satellite identification. The latter requirement necessitates an expeditious handling and classification of orbital data, and a presentation of results in ways that facilitate positive and immediate identification of "strange" satellites.

This report is the result of a preliminary study of prospective data handling and presentation procedures. Its purpose is to present the relative merits and limitations of various alternatives proposed, to indicate the particular methods worthy of serious consideration and further study, and to outline the time factors and development costs likely to be involved in procuring prototype equipment.

Discussion is limited to a general, rather than to a specific, treatment of the subject, because numerous pertinent details of instrumentation and orbital computation procedures are presently in a state of flux.

1,484 **DYNAMIC ANALYSIS OF A SIMPLE RE-ENTRY MANEUVER FOR A LIFTING SATELLITE**
Grant, F. C.
1959
National Aeronautics and Space Administration, Washington, D.C.
Technical Note D-47

The dynamic properties of a simple re-entry maneuver are presented. The maneuver is designed to put the re-entry vehicle on a smooth glide trajectory after a single skip. This maneuver is accomplished by a properly chosen aero-lift coasting period. The chosen coasting period satisfies general boundary conditions at the start of the glide. Wing loadings of 20 and 100 lb/sq ft are considered for re-entry angles up to 6 deg with a lift-drag ratio range of ½ to 5. Re-entry speeds corresponded to the energy levels of circular orbits at 655,000 and 490,000 ft.

The simple single-skip maneuver was possible over a wide range of the parameters considered but, naturally enough, was easiest at low lift-drag ratios. The effects of wing loading were generally small. The higher lift-drag ratio maneuvers were possible only at the higher re-entry angles. The minimum re-entry angle for a successful maneuver at a high lift-drag ratio was sharply reduced by the lower energy level. The precision of the maneuver was found to be highly sensitive to the time of the start of the coast and less so to the time of lift restoration. Coasting distances of less than 1,000 nm were only possible for lift-drag ratio values under about 2.

Maximum normal accelerations had a roughly parabolic variation with re-entry angle. The highest value calculated was 4.7 *g* at a lift-drag ratio of 5 for a wing loading of 100 pounds per square foot and a re-entry angle of 6 deg.

1,485 **ROTATION OF THE ORBITAL PLANE OF AN EARTH SATELLITE DUE TO THE ATMOSPHERE**
Cook, G. E.
March, 1959
Royal Aircraft Establishment, Farnborough, Great Britain
Technical Memorandum G.W. 351

The rotation of the orbital plane of an earth satellite, produced by the rotation of the earth's atmosphere, is investigated for a spherically symmetrical earth and atmosphere. Formulae are obtained for the rotation of the orbital plane in terms of the change in the orbital period or the change in the inclination to the equator. Numerical values are obtained for Sputnik 2 (1957 β) and it is found that, with present accuracies, the rotation is just small enough to be neglected, compared with that due to gravitational effects, but would have to be included in more accurate analyses.

1,486 **ARTIFICIAL METEORS STUDIES PHASES I AND II**
Shelton, H., Wuerker, R., Robinson, L. B., and Birkhoff, G.
February 28, 1958
Ramo-Wooldridge Corp., Los Angeles, Calif.
Electronic Research Laboratory
GM-TR-0127-00384
Final Report

Because the phenomena associated with impacts by macro-particles are of interest to designers of nose cones and orbiting vehicles, a program of Artificial Meteors Studies was undertaken. Much of the effort was devoted to experimental problems of accelerating micron-size particles to hypervelocities in the laboratory and quantitative analysis of experimental damage. Consideration was also given to the theoretical factors influencing crater formation.

The most promising method of accelerating micron-size particles to hypervelocities is by means of electric fields acting on charged particles. Perfecting techniques for charging proved to be the prime obstacle between theory and the realization of a practical electrostatic macro-particle accelerator, and investigation of this problem occupied more than three-quarters of the experimental program. A small 150-kv prototype accelerator was constructed, capable of yielding single particle impacts with measured incident velocity and mass on targets of evaporated aluminum on glass and micro-polished solid copper.

Concurrently with the experimental program, theoretical investigations were conducted on parameters influencing crater formation by micron-size particles at hypervelocities. Analysis was made of available impact data to determine possible means of extrapolation to meteoric impact speeds, and to illustrate the importance of certain material properties.

1,487 **1958 NASA/USAF SPACE PROBES (ABLE-1) FINAL REPORT**
June, 1959
Space Technology Laboratories, Inc., Los Angeles, Calif.
National Aeronautics and Space Administration
NASA Memo 5-25-59W Vol. I

The three NASA/USAF lunar probes of August 17, October 13, and November 8, 1958 are described. Details of the program, the vehicles, the payloads, the firings, the tracking, and the results are presented. Principal result was the first experimental verification of a confined radiation zone of the type postulated by Van Allen and others.

1,488 **NRL PARTICIPATION IN THE CSAGI ROCKET AND SATELLITE CONFERENCE**
September 30–October 5, 1957
Naval Research Laboratory, Washington, D.C.
NRL Report 5165

An international conference on rocket and earth satellite programs for the International Geophysical Year was held in Washington from September 30 to October 5, 1957. The conference was called by the Comité Speciale L'Année Geophysique Internationale (CSAGI), which asked the National Academy of Sciences to act as host. The conference brought together delegates from the various national committees participating in research rocket and satellite programs. The chairman was L. V. Berkner, CSAGI reporter on rockets and satellites and President of the International Council of Scientific Unions. Executive Director Hugh Osishaw, of the U.S. National Committee, IGY, was Chairman of the General Arrangements Committee.

NRL participation in the IGY has been preponderantly in the field of upper-air research; it was natural, then, that NRL papers delivered at the conference concern the development and use of rockets in research. These papers cover NRL earth satellites, their development and instrumentation, and the rocket vehicles which are used to propel them into orbit. Dr. John P. Hagen submitted the first NRL paper, which gave a comprehensive look at both the satellite and the vehicle. Subsequent papers submitted by NRL scientists and engineers covered such details of the Vanguard operation as the Minitrack system, optical tracking, satellite structure, satellite instrumentation, telemetering, and some of the experiments which will be carried out, including Lyman-alpha and magnetic field measurements and ionospheric study. The satellite environment was covered in papers on atmospheric drag satellite temperature control and measurement, and measurement of micrometeor impingement. Papers were also given which covered NRL upper-air research at Fort Churchill, White Sands Proving Ground, and the other stations throughout the world, from Baffin Bay to the Antarctic. These papers were largely confined to the preliminary results obtained during pre-IGY and early IGY rocket firings. One paper describes the Aerobee-Hi, a rocket specifically designed for high-altitude research.

1,489 A FLUID-DYNAMIC MECHANISM OF METEORITE PITTING
Williams, D. T.
1959
Smithsonian Institution, Washington, D.C.
Vol. 3, No. 6

Flow lines on meteorites were photographed to determine the nature of airflow inside the "thumb pits" in the surface. The flow is shown to be consistent with that occurring if a hairpin-shaped vortex were lying with bent portion in the pits, with vortex legs trailing off to infinity downstream. Since such a flow is not unique to supersonic fluid speeds, the prediction is made that pits similar to those on meteorites would be observed on salt cakes pushed through a lake. Experiments demonstrated that salt-cake erosion may indeed be accompanied by pit formation due to vortices precisely like those detected in meteorite pits. The evidence, supplied by photographs, leads to the conclusion that pitting is a general phenomenon in eroding fluid flow, and that tests at low speeds may provide valuable information regarding certain problems in astroballistic ablation.

1,490 MATERIALS IN SPACE ENVIRONMENT
September 16, 17, 18, and 19, 1958
(Co-sponsored by Army Ballistic Missile Agency and the Office of Ordnance Research of U.S. Army)
Syracuse University Research Institute, Syracuse, New York
MET 597-596

This conference included the following papers:

"Chemistry of the Moon," H. C. Urey; "Overall Objectives and Outline of Problems," W. H. Steurer; "Design Requirements of Space Vehicles," J. B. Cladis; "Physics of Space Vacuum and Effects on Materials," R. Herzog; "The Effect of Atmosphere on Creep and Fatigue at Elevated Temperatures," M. R. Achter; "High Vacuum Technique and Expected Effects on Materials," G. F. Vanderschmidt; "Thermal Problems of Satellites," G. H. Heller; "Surface Emissivity of Materials at Relatively Low Temperatures," R. McDonough; "Structural and Mechanical Effects of Repeated Cooling," E. T. Wessel; "Nature of High Energy Radiation Encountered in Space," P. Meyer; "Radiation Effects on Metals," E. Schmid; "Radiation Effects on Non-Metals," H. R. Dvorak; "Meteoric Influx," F. L. Whipple and G. S. Hawkins; "Meteorites and Cosmic Dust in Space," C. Tombaugh; "High Velocity Impact," W. S. Partridge; "Effects of Meteorites on Materials and Simulation Testing," C. N. Scully.

1,491 COMMENTS ON THE EPHEMERIDES AND CONSTANTS FOR A SOLAR ECLIPSE
(Eclipse Bibliography Appended)
Cameron, R. C.
May, 1959
Air Force Cambridge Research Center, Bedford, Mass.
AFCRC-TN-59-225 (ASTIA AD-215116)

Corrections to the spheroidal coordinates of a site on the earth's surface or to the geodetic distance between two sites that have been deduced by comparing the observed circumstances of an eclipse with their predicted values are uncertain by an amount that depends on: (1) the uncertainties in the geodetic and astronomical constants, (2) the errors in the ephemerides used in the eclipse calculations, (3) the errors of timing the contacts, and (4) the errors that arise in referring the points of contact to an ideal spherical moon. The effect of these various sources of error on the final result (site coordinates or geodetic distances) is discussed. Ways of minimizing these effects are outlined: for example certain known errors may be reduced, such as the error of inferring the moon's center from a portion of the limb, which may be nearly eliminated by applying Watt's limb corrections; certain unknown errors may be made to cancel out almost by a suitable choice of sites.

The best accuracy in the geodetic distance between two sites that is currently attainable under optimum conditions appears to be about 70 meters (p.e.), accuracy for absolute site coordinates is somewhat worse. This comes about chiefly from residual uncertainties in the values of the earth's radius and the lunar parallax, and in the determination of contact times. It is expected, however, that programs now in progress or projected for the near future, some of which are mentioned, will greatly improve these results.

In compiling the report the author consulted the extensive literature on the subject; the appended bibliography grew out of these efforts.

1,492 DISCONTINUED

1,493 **PHOTOTRACK BULLETIN INCLUDING A SATELLITE PHOTOGRAPHY TIMING SYSTEM**
Newell, R. F. Jr., and Rust, W. R.
June 23, 1959
Volunteer IGY Satellite Tracking Program, Washington, D.C.
IGY Project 30.21

This paper contains a general description of the system and its purposes. Appendix A is titled "Method of Determining the Iso-Error Diagram." Appendix B is titled "Determining Tape Recorder Speed."

1,494 **PROCEEDINGS OF THE AMERICAN ASTRONAUTICAL SOCIETY 2ND WESTERN NATIONAL MEETING**
August 4-5, 1959
American Astronautical Society, Palo Alto, Calif.

The keynote address was given by Dr. Wernher Von Braun. A panel discussion of the subject "Probing Space" was moderated by Homer Newell, Jr. with General Don Flickinger, A. G. Wilson, and J. G. Beerer as panelists. The conference was divided into six sessions. These sessions contained the following papers:

59-1 "Human Factors in Probing Outer Space"
Imus, H.
U.S. Naval School of Aviation Medicine

59-2 "Shielding and Nuclear Propulsion"
Trapp, R. and Konecci, E. B.
Douglas Aircraft Company

59-3 "Flight Trainer for Manned Orbital Vehicles"
Kuchnegger, W.
The Martin Company

59-4 "Human Factors in Space Craft Technology"
DeCallies, R. N.
Office of Naval Research

59-5 "Fuel Requirements for Crude Interplanetary Guidance"
Breakwell, J. V.
Lockheed Missiles and Space Division

59-6 "Guidance Requirements for Interplanetary Flight"
Kierstead, F. H.
Goodyear Aircraft Corporation

59-7 "Satellite Orbit Control System"
Fitzgibbon, M. C.
General Electric Company

59-8 "Scientific Significance of Deep Space Exploration"
Benedikt, E. T.
Douglas Aircraft Company

59-9 "Dynamic Response Surface for Non-Linear Equations of Power Flight"
Ross, R. E.
National Engineering Science Company

59-10 "Design Optimization of Thermal Radiators for Space Vehicles"
Cornog, R.
Thompson-Ramo-Wooldridge Corporation

59-11 "Solar Photovoltaic Power Sources for Space Vehicles"
Sailor, J. D.
Lockheed Aircraft Company

59-12 "The Problem of Electrical Neutrality in Ion Beams"
Fisher, E.
Lockheed Missiles and Space Division

59-13 "The Magnetic Pinch Engine for Space Flight"
Kunen, A., and McIlroy, W.
Republic Aviation Corporation

59-14 "Round Trip Trajectories for Mars Observation"
Johnson, P. G.
National Aeronautics and Space Administration

59-15 "A Systematic Approach to a Matrix of Space Research Vehicles"
Nicks, O. W.
Chance Vought Aircraft, Inc.

59-16 "The Influence of Launch Conditions on the Friendly Rendezvous of Astrovehicles"
Petersen, N. V., and Swanson, R. S.
Norair Division, Northrop Aircraft Corporation

59-17 "Effect of Re-Entry Technique on the Design of a Space Vehicle"
Stalony-Dobrzanski, J.
Hughes System Development Laboratories

59-18 "Satellite Communications"
Vilbig, F.
Air Force Cambridge Research Center

59-19 "Requirements of Data Transmission on Solar System Reconnaissance Vehicles"
Child, C. H.
Autonetics Division, North American Aviation, Inc.

59-20 "Measuring Amplitude and Phase"
Goodman, R.
Space Technology Laboratories, Inc.

59-21 "Design Techniques for Deep Space Television"
Viterbi, A.
Jet Propulsion Laboratory

59-22 "The Origin of the Gravitational Force"
Alzofon, F. E.
Lockheed Missiles and Space Division

59-23 "The Lunar Gravitational Potential"
Alexandrov, I.
Department of Physics, University of California, Los Angeles

59-24 "An Analytical Method for Determining the Orbital Characteristics of a Non-Lifting Body Which Passes Through the Lower Atmosphere of a Planet"
Gideon, G. S.
Chance Vought Aircraft, Inc.

59-25 "Lunar and Planetary Atmospheres"
Jastrow, R.
National Aeronautics and Space Administration

59-26 "Shock-Tube Experiments Simulating Entry Into Planetary Atmosphere"
Chan, K. K., and Rutowski, R. W.
Lockheed Missiles and Space Division

1,495 **RESEARCH IN SPACE SCIENCE**
Briggs, R. E., Slowey, J. W., and Leonard, A. S.
June 30, 1959
Smithsonian Institution, Cambridge, Mass.
Astrophysical Observatory
Special Report 27

Two papers are given: "An Iterative Method of Orbit Determination from Three Observations of a Nearby Satellite," by Briggs and Slowey; and "Determination of the Orbit of Satellite 1958 Beta One," by Leonard. A cumulative table of contents with Special Reports 11 through 27 is included in this report.

1,496 **INSTRUMENTATION FOR TRACKING SATELLITE IONOSPHERIC PAYLOADS**
July, 1959
Ballistic Research Labs, Aberdeen Proving Ground, Md.
Technical Note 1267

This report describes the DOVAP continuous-wave tracking system as it is used to track satellites. The DOPLOC and PARDOP systems are also explained and their applications described.

1,497 THE UNIVERSE DISCLOSES ITS MYSTERIES
(Pravda Article)
July 15, 1959
Zygielbaum, J. L., translation
July 31, 1959
Jet Propulsion Laboratory, California Institute of Technology
Pasadena
JPLAI/Translation No. 3

This translation contains the following chapters: The Investigation of Radiation Near the Earth and in Cosmic Space; The Study of the Upper Atmosphere; Investigation of Interplanetary Gas; The Study of the Earth's Magnetic Field; Micrometeors; Biological Investigations; and Basic Trends in the Development of Cosmic Flights.

1,498 SPACE PRIMER, AN INTRODUCTION TO ASTRONAUTICS
1959
Convair Division
General Dynamics Corporation, San Diego, Calif.

This pocket-sized handbook on astronautics contains information on rockets, satellites, the motion of bodies in space, the moon and planets, propulsion, escape from the earth, and the careers in astronautics. A glossary of terms used in astronautics is included as well as a bibliography on astronautics and astronomy.

1,499 DAMAGE TO X-RAY DETECTORS BY METEORITES
Broyles, A. A.
January 21, 1959
RAND Corp., Santa Monica, Calif.
RM-2314

A proposal has been made for placing X-ray detectors on satellites to monitor the background above the earth's atmosphere. Such a detector would be composed of (1) a thin beryllium window to cut off radiation of energy less than one kilovolt per photon, (2) a thin NA 1 crystal scintillator to convert the X-rays into visible or ultraviolet light, and (3) a photomultiplier tube to detect these photons from the scintillator.

This study estimates the effect of meteorites on a beryllium window covering an X-ray detector on a satellite, with the aid of the latest meteor density information from astronomical and satellite measurements. Bjork's formula for the depth of penetration of high velocity particles striking a surface is used to obtain the estimate that only one-millionth of the area of the window would be punched out by meteorites per year. Methods for reducing the amount of sunlight leaking through the holes to the photomultiplier tube are considered. Splitting the beryllium sheet into two parts appears advantageous for reducing the effect of window damage from the meteorites.

1,500 IN-FLIGHT IMPACT AND APOGEE COMPUTATIONS FOR VANGUARD
Germond, H. H.
May 25, 1959
Air Force Missile Test Center, Patrick Air Force Base, Fla.
AFMTC-TR-59-9
RCA Data Processing Technical Report 49
(ASTIA AD-216293)

The range, azimuth, and elevation of a Vanguard vehicle, as determined every 0.1 second by one or another of two radars, are used as input to a computer. Every tenth of a second during the powered first and second stages of flight a prediction is made as to where the vehicle would impact if the thrust were to be terminated. This information is displayed continuously on a plotting board.

After burnout or cutoff of the second stage, computations are made (every tenth of a second) of the time remaining before the vehicle should reach apogee. This and other information pertinent to the initiation of the third stage is displayed on a console.

1,501 ATTITUDE CONTROL OF A SATELLITE VEHICLE—AN OUTLINE OF THE PROBLEMS
Roberson, R. E.
Autonetics Division of North American Aviation, Inc.
Downey, Calif.
October 6-12, 1957
American Rocket Society
New York 36, New York
Paper 485-57

The attitude of a satellite vehicle must be controlled for many applications. This paper describes some of the fundamental problems associated with the design of an attitude control system. These include the choice of an attitude reference system and of reference axes within the body, and the nature of the attitude perturbation torques acting on the satellite. Attitude equations of motion are derived and a rationale for a control system synthesis is suggested. Control torque sources, the effects of vehicle configuration, and the role of attitude sensing devices are discussed.

1,502 **PROCESSES FOR THE PRODUCTION AND REMOVAL OF ELECTRONS AND NEGATIVE IONS IN GASES**
Silverman, S. M.
June, 1959
Air Force Cambridge Research Center, Bedford, Mass.
GRD Research Notes No. 16
AFCRC-TN-59-266 (ASTIA AD-216816)

A survey is presented of more important processes which are responsible for the production and removal of electrons and negative ions in the earth's atmosphere. An attempt is made to include references to all recent work on these processes and to indicate those areas in which additional work needs to be done.

1,503 **ADVANCES IN ASTRONAUTICAL SCIENCES, VOLUME 4 PROCEEDINGS OF THE 5TH ANNUAL MEETING OF THE AMERICAN ASTRONAUTICAL SOCIETY**
November, 1958
American Astronautical Society Publication, Palo Alto, Calif.

The following papers are included in this volume:

INTRODUCTION

"Space Exploration and Human Welfare"
Dryden, H. L.
National Aeronautics and Space Administration

PART I. UPPER ATMOSPHERE RESEARCH AND RE-ENTRY MECHANICS

"Heat Transfer in High-Speed Slip Flow"
Oman, R. A., and Scheuing, R. A.
Grumman Aircraft Engineering Corp., Bethpage, N.Y.

"Some Aspects of the Electrical Properties of the Upper Atmosphere"
Goldberg, P. A.
Boeing Airplane Company, Seattle, Washington

"Discontinuity Surfaces in Magneto-Fluid-Dynamics"
Napolitano, L. G.
Aerodynamics Laboratory, Freeport, New York
University of Naples, Italy

"A Study of Entry into the Earth's Atmosphere"
Cross, D. B.
The Martin Co., Baltimore, Maryland

"Horizon-Scanning for Atmospheric Re-Entry"
McCartney, E. J.
Sperry Gyroscope Company, Great Neck, L. I., New York

"On Gravitation"
Gradecak, V.
Ryan Aeronautical Company, San Diego, Calif.

PART II. SPACE VEHICLE DESIGN

"The High-Temperature Research Challenge in Space-Vehicle Design"
Glaser, P. E.
Arthur D. Little, Inc., Cambridge, Mass.

"Solar Turbo-Powerplant Design"
Mackay, D. B., and Leventhal, E. L.
North American Aviation, Inc., Downey, Calif.

"Lubrication Problems in Space Vehicles"
Freundlich, M. M., and Robertson, A. D.
Airborne Instruments Laboratory, A Division of Cutler-Hammer, Inc., Mineola, N.Y.

"Assembly of a Multi-Manned Satellite"
Byers, R. A., and Kramer, S. B.
Lockheed Aircraft Corporation, Sunnyvale, Calif.

"Space Vehicle Attitude Problems"
Perkel, H.
Astro-Electronic Products Division, Radio Corporation of America, Princeton, N.J.

PART III. GUIDANCE AND INSTRUMENTATION

"Simplified Space Guidance System Analysis"
Brown, C. A., and Fleisig, R.
Sperry Gyroscope Company, Great Neck, L.I., N.Y.

"Proposed Method of Navigation on the Earth by Means of an Earth Satellite"
Etcheverry, R., Brooks, R., and Russell, J.
U.S. Naval Ordnance Test Station, China Lake, Calif.

"Long-Range Detection by Star Occultation"
Dubner, H.
Avion Division, ACF Industries, Inc., Paramus, N.J.

"A Television Camera for Space Applications"
Mesner, M. H., Staniszewski, J. R., and Werenfels, P. H.
Radio Corporation of America, Princeton, N.J.

"Guidance Analysis for Ballistic Interplanetary Trajectories"
Magness, T. A., McGuire, J. B., and Smith, O. K.
Space Technology Laboratories, Inc., Los Angeles 45, Calif.

PART IV. SATELLITE MECHANICS AND SPACE EXPLORATION

"Orbit Decay and Prediction of the Motion of Artificial Satellites"
Michielsen, H. F.
Lockheed Aircraft Corporation, Missiles and Space Division,
Palo Alto, Calif.

"Perturbed Motion of Selenoid Satellites"
Benedikt, E. T., Levin-Cohen, P. S.
Research Section, Engineering Department, Missiles and Space Systems,
Douglas Aircraft Company, Inc.

"Satellite Rotation"
Bracewell, R. N.
Stanford University, Palo Alto, and Stanford Research Laboratory,
Menlo Park, Calif.

"Corpuscular Radiation Around the Earth"
Van Allen, J. A.
Professor of Physics, State University of Iowa, Iowa City, Iowa

"Artificial Modification of the Earth's Radiation Belt"
Singer, S. F.
Professor of Physics, University of Maryland, College Park, Maryland

"Satellite Rendezvous Operations"
Petersen, N. V.
Lockheed Aircraft Corporation, Missiles and Space Division,
Palo Alto, Calif.

PART V. ROCKETS AND SATELLITES

"Rocket Exploration of the High Atmosphere for the IGY"
Townsend, J. W., Jr.
Chief, Space Sciences Division, National Aeronautics and Space
Administration, Washington, D.C.

"Rocket Astronomy"
Friedman, H.
U.S. Naval Research Laboratory, Washington, D.C.

"Radio Observations of the Earth Satellites"
Swenson, G. W., Jr.
Departments of Astronomy and Electrical Engineering,
University of Illinois

"The Variable Acceleration of Satellites"
Jacchia, L. G.
Astrophysical Laboratory, Smithsonian Institution, Cambridge, Mass.

"Some Results from the Pioneer III Flight"
Pickering, W. H.
Jet Propulsion Laboratory, California Institute of Technology, Pasadena

PART VI. MAN'S ENVIRONMENT IN SPACE

"The Man-Machine System in Space Vehicles"
Hoover, G. W.
Director, Technical Planning, Benson-Lehner Corp., Los Angeles, Calif.

"Protection of Man Against Transient Exposure to High Heat Loads"
Webb, P., M.D.
Aero Medical Laboratory, Wright Air Development Center,
Wright-Patterson AFB, Ohio

"Physiological Telemetry"
McLennan, M. A.
Wright Air Development Center, Wright-Patterson AFB, Ohio

"Biodynamics of Launch and Re-Entry Profiles"
Hiatt, E. P.
Chief, Biophysics Branch, Aero Medical Laboratory, Wright Air
Development Center, Wright-Patterson AFB, Ohio

"Psychological Research in the Environment of Outer Space: Animal
Experimentation"
Rohles, F., Jr.
Aero Medical Laboratory, Wright Air Development Center, Ohio

"A Comparison of Artificial Environments Used in Sealed Cabins During
Flights into the Stratosphere"
Ross, M. D.
Air Branch, Office of Naval Research, Washington, D.C.

"Closed Ecological Subsystems . . . Some Practical Application Problems in
Manned Space Flight"
Pinc, B. W.
Air Force Ballistic Missile Division, Air Research and Development
Command, Los Angeles, Calif.

"Exploratory Research on the Theoretical Consideration of Waste Water
Cycles in a Closed Ecological System"
Ingram, W. T., Newman, B., Palevsky, G., and Slote, L.
College of Engineering, New York University

The papers listed in the appendix were presented as a part of the program but were not available for inclusion in these proceedings:

APPENDIX

"The Flight of the Monkey in the Joint Army-Navy Biological Experiment"
Barr, N.
Deputy Director, Research Division, Bureau of Medicine and Surgery,
Dept. of the Navy, Washington, D.C.

"Survival of Terrestrial Micro-Organisms Under Simulated Martian Conditions"
Fulton, J. D.
Dept. of Microbiology-Cellular Biology, School of Aviation Medicine, USAF, Randolph AFB, Texas

"On the Relation of Oxygen Consumption to Oxygen Tension"
Beischer, D. E.
U.S. Naval School of Aviation Medicine, U.S. Naval Aviation Medical Center, Pensacola, Fla.

"Atmosphere Contaminants and Their Control"
Duffner, G. J.
Bureau of Medicine and Surgery, Dept. of the Navy, Washington, D.C.

ASTRONAUTICS INFORMATION ABSTRACTS, PART D

September 1–December 31, 1959

1,504 ABLATION IN HYPERSONIC FLOWS
(Presented at the 7th Anglo-American Aeronautical
Conference, October 5–7, 1959, New York, N. Y.)
Lees, L.
California Institute of Technology, Pasadena
Institute of the Aeronautical Sciences, Inc., New York 21, N. Y.
IAS Paper 59-146

Recent theoretical investigations have contributed to our understanding of the fluid mechanics of ablation. The large increase in effective heat capacity produced by gaseous ablation is attributed partly to the well-known "heat blockage" effect of mass addition, and partly to infra-red radiation from the gas-liquid or gas-solid interface. Results of some experimental studies of ablation in hypersonic wind tunnels and electric-arc driven tunnels are discussed, and the application of ablating materials to spacecraft entering a planetary atmosphere is treated briefly in order to illustrate the flexibility of ablating heat sink systems.

1,505 A POSSIBLE TRANSPONDING SYSTEM FOR AN
ARTIFICIAL ASTEROID
Swerling, P., and Crain, C. M.
May 14, 1958
RAND Corp., Santa Monica, Calif.
RM-2172
(ASTIA AD-156,036)

The measurement of transmission path length to an artificial asteroid by radio frequency transponding techniques has been suggested as a means of increasing the precision with which the dimensions of the solar system are known.

This report describes the design of a possible pulsed transponding system by which the transmission path length could be measured with an accuracy limited essentially by the accuracy with which the velocity of light is known—i.e., about one part in 10^6. Typical values of range and radial velocity with respect to the Earth of the proposed artificial asteroid are assumed.

All assumed components are presently available. A weight and volume breakdown of a possible design is given, which indicates that the necessary asteroid-borne transponding equipment, with associated power sources, could be accommodated in a 15-lb package occupying about 900 cubic in.

1,506 **A MAN IN SPACE**
Danilin, B.
***Izvestia*, July 24, 1959**
Zygielbaum, J. L., translation
August 13, 1959
Jet Propulsion Laboratory, California Institute of Technology, Pasadena
JPLAI/Translation No. 4

This report presents a survey of the problem which will be encountered in the course of putting a man into space and bringing him back to Earth again safely. These problems are: acceleration, weightlessness, meteor bombardment, cosmic radiation, and re-entry.

1,507 **THE ELEMENTS OF A DEEP-SPACE TRACKING SYSTEM; THE TRACKING OF *PIONEER IV***
Richter, H. L., Jr., and Stevens, R.
August 13, 1959
Jet Propulsion Laboratory,
California Institute of Technology, Pasadena
External Publication 685

The elements of the design of a world-wide tracking system for deep-space vehicles are discussed. The system includes three stations consisting of large-aperture antennas and high sensitivity receivers. The criteria for the selection of tracking sites is discussed; sites should be located around the Earth to give overlapping coverage from one to the next, and should be placed in noise-free locations to take advantage of low-noise receiver techniques. The reasons for the selection of an antenna size of the order 85 ft and a frequency in the vicinity of 2000 mc are discussed.

1,508 **GRAPHICAL REPRESENTATION OF RE-ENTRY TRANSFER ORBITS**
Wolaver, L. E.
March, 1959
Wright Air Development Center
Wright-Patterson AFB, Ohio, Aeronautical Research Lab.
WADC TN-59-141 (ASTIA AD-214,761)

This report represents an analysis of two-dimensional transfer orbits between a circular orbit in a vacuum above a spherical Earth and a point on that rotating

Earth. These re-entry orbits are characterized by two parameters, e, the eccentricity and, p, the semi-latus rectum. The report presents constant loci lines in the e-p plane; these are modified Vertregt diagrams. The loci considered consist of re-entry angle, re-entry velocity, retro-thrust required, retro-thrust alignment angle, time-to-impact, range to impact, target lead angle at application of retro-thrust, and target-satellite angle at impact. Both the direct and apogee routes are considered.

1,509 **THE CLOCK PARADOX IN SPECIAL RELATIVITY**
MacDuffee, C. C.
June, 1959
University of Wisconsin, Madison
MRC Technical Summary Report No. 92

Since there are conflicting opinions as to the validity of the clock paradox and no complete mathematical proof exists, the attempt is made to provide such proof.

1,510 **PART I. EPHEMERIS OF SATELLITE 1957 ALPHA 2**
PART II. COLLECTED REPORTS ON SATELLITE OBSERVATIONS
Eckels, A., Koidan, R., Harris, I., and Jastrow, R.
June 15, 1959
National Academy of Sciences, Washington, D. C.
IGY Satellite Report Series No. 8

A complete ephemeris of *Sputnik I* is given for the period October 5–25, 1957. Part II of this document contains selected reports that have previously been published separately. These include Smithsonian Astrophysical Observatory Special Reports No. 22, plus excerpts from No. 18–21.

1,511 **RADIATION MEASUREMENT TO 658,300 KILOMETERS WITH *PIONEER IV***
Van Allen, J. A., and Frank, L. A.
August, 1959
Iowa, State University of, Iowa City
SUI-59-18

This report comprises: (1) the radiation observations obtained with the U.S. deep-space probe *Pioneer IV*; (2) a comparison of these observations with those of *Pioneer III* and of the first Soviet cosmic rocket; and (3) an interpretive discussion.

1,512 **THE SEARCH FOR SMALL NATURAL EARTH SATELLITES**
Tombaugh, C.W., Robinson, J. C., Smith, B. A., and Murrell, A. S.
June 30, 1959
New Mexico College of Agriculture and Mechanic Arts, State College, Physical Science Laboratory
Final Technical Report

This report describes the entire search for small natural Earth satellites from its inception, through the development of various procedures, to the statistical conclusions.

Several fairly promising, but faint, satellite suspects were encountered. Vigorous attempts were made to recover them, but without success. It was concluded that these objects were probably spurious, although they could have been satellites of high eccentricity beyond the practicality of recovery. Indeed, they may have been very small asteroids brushing by the Earth in their elliptical orbits around the Sun. The extensive search conducted by this project indicates that the satellite regions of the Earth are remarkably free of natural discrete bodies. It appears that the Earth has only one natural satellite; namely, the Moon.

1,513 **METEOR TRAINS**
Hughes, R. F.
1959
Smithsonian Institution, Washington, D. C.
Vol. 3, No. 8

Data are presented on the heights, duration, and intensities of 48 meteor trains. The beginning and end points of the meteor trains correlated well with those of the meteor trail. The points of maximum train intensity coincide with the heights of maximum meteor luminosity throughout the lifetime of the luminescence, for trail maxima about 85 km. The atmospheric region below this altitude is very unfavorable for the occurrence of long duration trains. The initial formation of a train is much more efficient for high-velocity meteors. The relatively longer duration trains show no velocity preference due to a balance between the higher probability of train formation by high velocity, hence high altitude meteors, and the greater probability of persistence for a train formed at lower altitudes by low-velocity meteors. About three-fourths of the train meteors move in retrograde long period orbits and the remaining train meteors with low atmospheric velocities move in direct, short-period, and highly eccentric orbits. The cometary-asteroid criterion suggested by Whipple indicates that all the trains were formed by cometary meteoroids.

1,514 PERIODIC SURFACES AND SATELLITE ORBITS
Diliberto, S. P.
May 1, 1959
Naval Ordnance Test Station, China Lake, Calif.
NAVORD Report 6445
NOTS Technical Publication 2153

This report contains a mathematical study of conservative dynamical systems. For the types of systems under consideration the problem studied is that of determining integrals in addition to the energy integral–or equivalently of reducing the order of the equations.

A new technique for determining a suitable coordinate system is developed. When applied to the problem of satellite orbits it is shown that certain earlier conclusions are true, but for a wider class of orbits than previously considered.

1,515 PERIODIC ORBITS OF A PLANETOID PASSING CLOSE TO TWO GRAVITATING MASSES
Newton, R. R.
1959
Smithsonian Institution, Washington, D. C.
Vol. 3, no. 7

This paper presents a study of periodic orbits in the restricted three-body problem in which the small mass passes close to each of the large masses. The orbits are classified according to the types of motion involved and methods are given for estimating initial conditions for the various classes of orbit. Some sample orbits, as determined by a digital computer are presented.

1,516 SATELLITE TRACKING BY RADIO
April 7, 1959
Air Force Cambridge Research Center, Bedford, Mass.
Interim Report No. 1, Part 1

This document presents the results of a mathematical study of tracking methods and recommendations for further analytical work. Such additional work would consist chiefly of an error analysis of the effect of inherent measurement errors in angle and doppler shift data on orbit determination. This analysis is a prerequisite to the choice of an optimum tracking system.

1,517 **MATERIALS FOR RE-ENTRY HEAT PROTECTION OF SATELLITES**
Steg, L.
1959
General Electric Co., Philadelphia, Pa., Aerosciences Lab.
Paper

It has now been demonstrated that ablation techniques are capable of providing heat protection to vehicles during hypersonic re-entry into the Earth's atmosphere.

There are essentially four types of materials: material which gasifies but does not liquefy; material which reacts at its surface with the constituents of dissociated air; material which melts and vaporizes; and material which partially gasifies, the remaining material being removed by surface combustion.

The result of a theoretical analysis for a typical re-entry trajectory is presented together with some experimental data on materials illustrating some of the four types, namely Teflon, graphite, quartz, and phenolic-nylon. The satellite re-entry environment was simulated in an electric-arc driven tunnel.

Comparison is also made between results in low heat transfer and high heat transfer environment to illustrate differences in behavior between steady-state and non-steady-state ablation.

Preliminary conclusions are drawn relative to the utility of each of the typical materials concerned. Some suggestions concerning improved materials are offered.

1,518 **INTERPLANETARY NAVIGATION USING CELESTIAL REFERENCES**
Wilcox, H. A., Pierce, F., and Haugner, R. C.
October 1, 1958
Naval Ordnance Test Station, China Lake, Calif.
NOTS 2081

A brief survey of the interplanetary navigation problem is presented. The conclusions derived are: (1) High thrust propulsion is particularly important for orbits which minimize the total velocity increments required. (2) To change trajectory energy most efficiently, velocity increments should if possible be added parallel (or anti-parallel) to the existing velocity vector when it is largest. To change trajectory direction and angular momentum most efficiently, velocity increments should if possible be added at right angles to the existing velocity vector when it is smallest and the vehicle is farthest from the origin of coordinates. (3) Calculations can be approximately carried out with a small computer, and rocket fuel can be used to correct trajectory errors; or else, a larger computer can be used to improve the calculations with a certain saving in rocket fuel. (4) Capture into a satellite orbit about the terminal planet by use of atmospheric drag techniques puts very stringent requirements on navigational accuracy, knowledge of atmospheric density-altitude and composition characteristics. (5) Stellar observations can be used to find vehicle attitude and $\dot{\theta}$ which is equal to the change in rate of attitude with respect to time. Angular planetary subtense at various wavelengths can be used to find target planet radius and depth of atmosphere. The mass of the target planet, and perhaps its atmospheric characteristics, can be measured by firing of a test body. Stellar parallax, stellar aberration, or the optical doppler shift cannot be used to obtain navigational information of adequate accuracy.

1,519 **THE FIRST SOVIET MOON ROCKET**
1959
U. S. Congress, Washington, D. C.,
86th Congress, First Session

This report was prepared for the use of the Committee on Science and Astronautics. It contains a summary of the information released by the USSR on the Soviet Cosmic Rocket which was launched January 2, 1959. The implications of this accomplishment as to the status of Russian space technology are discussed.

1,520 **DESIGN OF AN ALGAL CULTURE CHAMBER ADAPTABLE TO SPACE SHIP CABIN**
Gaume, J. G.
May, 1958
Air Force School of Aviation Medicine,
Randolph AFB, Texas
R-58-61

The complete design considerations for a closed oxygen recirculating system using green alga (chlorella pyrenoidosa) are given in this paper.

1,521 ***JUPITER* MISSILE SHOT—BIOMEDICAL EXPERIMENTS**
June 3, 1959
U. S. Congress, Washington, D. C.
86th Congress, First Session
Number 35

The committee questioned NASA members on the death of the primate Astronaut Able. It could not be firmly established that her death was influenced by the *Jupiter* flight.

1,522 **THE CONTENTS OF INTERPLANETARY SPACE**
Munch, G.
October 8, 1958
Space Technology Laboratories, Los Angeles, Calif.

The possible effects of the matter contained in interplanetary space on radio communication with space probes are discussed in this report. It is shown that we do not know very much about the composition of space matter. The only sources of information available at this time are: optical and radio observations of the solar corona; the zodiacal light; and meteors and meteorites.

1,523 **A METHOD OF DESCRIBING MISS DISTANCES FOR LUNAR AND INTERPLANETARY TRAJECTORIES**
Kizner, W.
August 1, 1959
Jet Propulsion Laboratory,
California Institute of Technology, Pasadena
External Publication 674

Miss distances for lunar and interplanetary trajectories can be described by specifying two components of the impact parameter, which is treated as a vector. This is analogous to the use of range and azimuth (or cross range) in specifying the impact point for terrestrial targets. The resulting coordinates are very nearly linear functions of the variables of the trajectory near the Earth, except in cases where the trajectory is of the minimum-energy type, such as Hohmann orbit. Applications are given to the theory of guidance and to a method for automatically searching for a trajectory which hits or misses the target in a specified manner.

1,524 **TRACKING AND DATA HANDLING FOR THE *PIONEER III* AND *PIONEER IV* FIRINGS**
Eimer, M., and Stevens, R.
August 14, 1959
Jet Propulsion Laboratory,
California Institute of Technology, Pasadena
External Publication 701

The three major requirements of the tracking and data-handling network which was used for *Pioneers III* and *IV* were (1) to provide continuous reception of telemetering data to several tens of thousands of kilometers in order to receive cosmic-ray data from the outer radiation bands, (2) to communicate to distances beyond the Moon, and (3) to make the precision angular measurements required for accurate determination of the flight paths of the probes. The cosmic-ray data measured by the vehicles were encoded in a unique way to maximize the information transmission capability for the limited bandwidth available with the communications system. The tracking network consisted of doppler and angle tracking stations in Florida, Puerto Rico, and California which had the capability of phase-coherent detection of the transmitted carrier signal, automatically encoding the time-tagged tracking data into standard teletype format and transmitting the information to a digital computer in California. The data were analyzed there to provide rapid and precise acquisition pointing information for the tracking stations and accurate determination of the vehicle paths.

1,525 PAYLOAD LOSS FOR EQUATORIAL ORBITS DUE TO NON-EQUATORIAL LAUNCHES
Eaton, M. L., and Garcia, M. A.
July 29, 1959
Navy Dept., Pacific Missile Range,
Point Mugu, Calif.
PMR-TM-59-4

This is the second report issued on this subject from this source (AIA 1,391), and is essentially a much expanded version of the first.

The primary purpose of this study is to provide estimates of satellite payload losses due to obtaining equatorial orbits from non-equatorial launch sites. In establishing this loss it is convenient to compare the payload placed in orbit from a launch, say at latitude λ, with the payload placed in orbit from a launch at the equator, and to express this difference or loss as a per cent of the payload in orbit from the equator. Essentially, it is desired to define this loss as a function of the launch site latitude.

1,526 ANALYSIS OF CENTRAL FORCE SYSTEMS IN THE PRESENCE OF SMALL DISTURBING FORCES
Pohle, F. V., and Feitis, P.
June, 1959
Polytechnic Institute of Brooklyn, New York
PIBAL Report 498

General theorems which relate to central force systems are presented and the effects of drag are included. Perturbation methods of solution are indicated in terms of dynamical invariants and energy equations are given for the cases of disturbed motion. The hodograph representation is used to supplement the discussion.

1,527 THE THERMAL PROTECTION OF RE-ENTRY SATELLITES
Scala, S. M.
1959
General Electric Co., Philadelphia, Pa.,
Aerosciences Lab.
Paper

An analysis is presented of the heat flux to a re-entry satellite for three different values of the ballistic parameter W/C_DA, i. e., 50, 100 and 200. Three basic types of heat alleviation schemes are then considered. These are the heat sink, the regulated mass transfer system and the self-regulating mass transfer system. The effectiveness of the three schemes is compared in terms of the total mass of material required for each.

1,528 **LABORATORY EXPERIMENTAL STUDIES IN RE-ENTRY AEROTHERMODYNAMICS**
(Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959)
Warren, W.
1959
General Electric Co., Philadelphia, Pa.,
Aerosciences Lab.
Paper

The integrated aerodynamic and thermodynamic problems of atmospheric re-entry are discussed in terms of their relationship to current and future re-entry vehicles. The over-all problem area is divided into separate areas that are amenable to experimental studies on a laboratory scale. The capabilities in these problem areas of existing test facilities—wind tunnels, shock tunnels, continuous arc heaters, etc.—are discussed.

Detailed performance characteristics of two high enthalpy test devices—the shock tunnel and the air arc facility—are presented and it is shown that they are complementary to each other in allowing study of many of the re-entry problems of present interest. Test facilities of these types have been in development and operation for several years at the Missile and Space Vehicle Department of the General Electric Company. To illustrate their usefulness, examples of experimental data obtained in the 6-in. shock tunnel and in several arc-heated facilities, including a 2500 kw (test gas power) unit, are presented. These include the results of shock tunnel studies on flow field visualization, surface pressure distributions, surface heat transfer distributions, and aerodynamic force measurements and the results of arc studies on materials suitable for use in ablation heat protection systems.

In conclusion, a critique is made of the status of present laboratory test facilities in terms of the re-entry problems that will require future investigation. It is postulated that the arc-heated wind tunnel, because of its many desirable characteristics, has a higher potential than other laboratory facilities in the study of re-entry aero-thermodynamic problems. To support this viewpoint, the performance of a relatively large arc wind tunnel, the design of which appears feasible on the basis of current state-of-the-art considerations, is presented and discussed briefly.

1,529 **NUCLEAR THERMOELECTRIC POWER SUPPLY**
(Presented at the AIEE Summer and Pacific General Meeting and Air Transportation Conference, Seattle, Washington, June 21–26, 1959)
Harvey, R. J.
Martin Co., Baltimore, Md.
American Institute of Electrical Engineers, New York 18, N. Y.
CP 59-911

Nuclear power, with its self-contained long-lasting fuel package, its compact design, and capability of high-temperature operation, opens up one of the more promising avenues of inquiry. Direct conversion of nuclear heat to electric power is especially attractive for space vehicles in view of the necessity for long, reliable life.

This paper summarizes preliminary work on a thermoelectric space power supply, operating from a reactor heat source. The study, which resulted in a conceptual design, was carried out with reference to a set of specifications describing the more or less ideal space power supply, namely: electrical power output of 2 to 10 kw; no repetitively moving parts or coolant loops; maintenance-free operation at full power for a minimum of one year; orbital or post-launch startup capability; five-year lead time for development of prototype; and minimum overall weight and size, consistent with the other requirements.

It is entirely possible that one or more of these assumed specifications is over-restrictive, requiring revision to arrive at an optimum system. The fact that the system falls short of one or more of the specifications is an indication either of an area in need of research and development or of an approach that should be changed.

1,530 MINIMIZING THE WEIGHT OF THERMOELECTRIC GENERATORS IN SPACE APPLICATIONS

(Presented at the AIEE Summer and Pacific General Meeting and Air Transportation Conference, Seattle, Washington, June 21–26, 1959)

Kerr, D. L., and Gessner, R. L.
General Electric Co., Schenectady, N. Y.
American Institute of Electrical Engineers,
New York 18, N. Y.
CP 59-937

The importance of reliability and weight as performance criteria for equipment to be used in space vehicles is stated. The inherent potential advantage of a thermoelectric generator and other static devices from the standpoint of reliability is pointed out. The need is indicated for making weight estimates of thermoelectric generator systems on a consistent basis for purposes of evaluation and direction of future work. A thermoelectric generator system for providing auxiliary power for space vehicles is defined, and some discussion is given of the role of efficiency in weight minimization. Finally, an approach for predicting and minimizing the weight of a thermoelectric generator is briefly outlined and results of a number of calculations using this procedure are presented.

1,531 AN ELEMENTARY DESIGN DISCUSSION OF THERMOELECTRIC GENERATION
(Presented at the AIEE Summer and Pacific General Meeting and Air Transportation Conference, Seattle, Washington, June 21–26, 1959)
Bollmeier, E. W.
Minnesota Mining and Manufacturing Co., St. Paul
American Institute of Electrical Engineers,
New York 18, N. Y.
TP-59-867

This paper seeks to acquaint the reader with the elementary problems of thermoelectric generation and some of the solutions devised by those with whom the author is associated. Consideration is also given to the advantages and disadvantages of thermoelectric generation for uses which may appear desirable at the present state of the art.

1,532 A THERMIONIC POWER SUPPLY USING SOLAR HEAT FOR SPACE APPLICATION
(Presented at the AIEE Summer and Pacific General Meeting and Air Transportation Conference, Seattle, Washington, June 21–26, 1959)
Casey, E. F., and Street, G., Jr.
General Electric Co., Schenectady, N. Y.
American Institute of Electrical Engineers, New York 18, N. Y.
CP 59-904

This paper deals with the possibilities of thermionic application to a space power supply using solar energy as a heat source.

1,533 OPTIMUM REFLECTOR-ABSORBER GEOMETRY FOR A SOLAR GENERATOR
(Presented at the AIEE Summer and Pacific General Meeting and Air Transportation Conference, Seattle, Washington, June 21–26, 1959)
Stineman, R. W.
Boeing Airplane Co., Seattle, Washington
American Institute of Electrical Engineers, New York 18, N. Y.
TP-59-869

As an initial step toward the eventual realization of a completely static system for converting solar radiation to electric power, the analysis and testing of a laboratory thermoelectric generator has been undertaken. A description of the over-all project is given. An essential part of the over-all system is the combination of reflector and absorber used to collect and concentrate the solar radiation. This paper deals with the geometrical optimization of the reflector and absorber.

1,534 PHOTOVOLTAIC SOLAR ENERGY CONVERTERS FOR SPACE VEHICLES—PRESENT CAPABILITIES AND OBJECTIVES (Presented at the AIEE Summer and Pacific General Meeting and Air Transportation Conference, Seattle, Washington, June 21–26, 1959)
Francis, A. B., and Happ, W. W.
Lockheed Aircraft Corp., Missiles and Space Division, Sunnyvale, Calif.
American Institute of Electrical Engineers, New York 18, N. Y.
CP 59-886

The objective of this paper is a critical analysis of: experimental data of silicon solar cells under various operating conditions and environment; methods of overcoming present limitations of silicon solar cells, and preliminary results on potential new materials and device designs; and problems arising from the unique properties of the silicon solar cells as a circuit element.

1,535 ELECTROCHEMICAL AUXILIARY POWER SOURCES FOR MISSILES AND SPACE FLIGHT (Presented at the AIEE Summer and Pacific General Meeting and Air Transportation Conference, Seattle, Washington, June 21–26, 1959)
Eisenberg, M.
Lockheed Aircraft Corp., Missiles and Space Division, Sunnyvale, Calif.
American Institute of Electrical Engineers, New York 18, N. Y.
CP 59-835

Fuel cells are discussed as a means of providing an auxiliary power source for space vehicles. The limitations of primary batteries and secondary storage batteries for this purpose are compared with the advantages of fuel cells.

The primary considerations for development of a highly efficient fuel cell power source are analyzed.

1,536 SOLAR-MECHANICAL POWER PLANT DESIGN PROBLEMS (Presented at the AIEE Summer and Pacific General Meeting and Air Transportation Conference, Seattle, Washington, June 21–26, 1959)
Stem, J. M.
Wright Air Development Center, Wright-Patterson AFB, Ohio
American Institute of Electrical Engineers, New York 18, N. Y.
CP 59-903

This paper will attempt to present an analysis of one particular system which shows promise for the immediate future. The method of analysis presented should have application to the majority of thermal energy conversion systems for space applications.

The particular system to be considered is a solar-mechanical power plant operating on a Rankine turbine cycle with mercury as the working fluid. The purpose is to parametrically analyze the system and its components and discuss the problems associated with them.

1,537 **CONCEPTUAL DESIGN OF A THERMIONIC SPACE POWER PLANT**
(Presented at the AIEE Summer and Pacific General Meeting and Air Transportation Conference, Seattle, Washington, June 21–26, 1959)
Huffman, F. N.
Martin Co., Baltimore, Md.
American Institute of Electrical Engineers, New York 18, N. Y.
CP 59-910

The current search for a reliable and simple space vehicle power plant has stimulated studies of thermoelectric, photoelectric and thermionic schemes for the direct conversion of heat to electricity without rotating parts. Treated here in elementary fashion are the basic principles of thermionic conversion, and a conceptual design is presented for a 25-kw space power plant subject to the constraint of no repetitive moving parts.

1,538 **ELECTROSTATIC POWER GENERATOR FOR SPACE PROPULSION**
(Presented at the AIEE Summer and Pacific General Meeting and Air Transportation Conference, Seattle, Washington, June 21–26, 1959)
Breaux, O. P.
Wright Air Development Center, Wright-Patterson AFB, Ohio
American Institute of Electrical Engineers, New York 18, N. Y.
CP 59-914

The actual potentialities of vacuum operating rotating plate electrostatic generators have not been fully explored in spite of their inherent low losses and simplicity. These devices have several characteristics which are advantageous for ion propulsion, operation in a vacuum, generation of power at high voltage, and high efficiency. Further development could make the vacuum electrostatic generator competitive with electromagnetic machines for ion rocket systems.

1,539 **SOLAR-POWERED THERMOELECTRIC GENERATOR DESIGN CONSIDERATIONS (Presented at the AIEE Summer and Pacific General Meeting and Air Transportation Conference, Seattle, Washington, June 21–26, 1959)**
Schuk, N. F.
Westinghouse Electric Corp., Lima, Ohio
Tallent, R. J.
Boeing Airplane Co., Seattle, Washington
American Institute of Electrical Engineers, New York 18, N.Y.
TP-59-847

One secondary power supply system that appears to show considerable merit is a solar-powered thermoelectric generator. Solar power is fairly abundant in space, and the solar-powered system would have an advantage in that it would require no fuel or shielding. The thermoelectric generator is a static conversion device and should have a fairly long life with good reliability. This paper presents, in a brief manner, some of the principles and problems which may be expected in applying solar energy to a thermoelectric generator serving a space vehicle, and describes a small solar-powered thermoelectric generator which was constructed to study these problems.

1,540 **SPACE ELECTRIC POWER TRANSMISSION (Presented at the AIEE Summer and Pacific General Meeting and Air Transportation Conference, Seattle, Washington, June 21–26, 1959)**
Bills, G. W.
North American Aviation, Inc., Downey, Calif.
American Institute of Electrical Engineers, New York 18, N, Y.
CP 59-861

In the early phases of space travel it seems certain that there will be space stations in orbit which will act as centers for assembling lunar and planetary exploration space craft. A nuclear-powered electric power station may be used from which transmission lines will extend out to numerous service stations necessary for the various activities involved in interplanetary flight preparations. Also for bases on the Moon and other planets it may be necessary to have central nuclear reactor power stations from which power would be available over power lines.

In all cases, transmission lines and energy sources must be weight minimized to conserve propulsive effort needed for lifting them into orbit. Thus it is obvious that space electric power transmission line design must be based on weight conservation principles rather than on the conventional cost basis familiar to all transmission line engineers. This paper discusses some materials and design factors applicable to this problem.

1,541 PRACTICAL CONSIDERATIONS OF AN ION PROPULSION SYSTEM (Presented at the AIEE Summer and Pacific General Meeting and Air Transportation Conference, Seattle, Washington, June 21–26, 1959)
Lennert, A. E.
Martin Co., Baltimore, Md.
American Institute of Electrical Engineers, New York 18, N. Y.
TP-59-833

The ion rocket is a reasonable system which has the inherent growth potential to power a space vehicle on extended journeys. In various forms, it has been the subject of several papers. This paper presents a parameter study of the ion propulsion system in terms of driving a 20,000-lb vehicle into space where the power source stems from the direct conversion of nuclear to electrical energy.

1,542 A PRACTICAL INVESTIGATION OF SPACESHIP CONTROL PROBLEMS (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959)
Cross, C. A.
284 London Road, Northwick, Cheshire, United Kingdom

Equipment is described that has been used to investigate manned space flight techniques. The spaceship flight simulator consists of a control panel, an electro-mechanical computer, and a planetarium type projector. A pen in the computer duplicates the motion of the spaceship on a scale of one in. to 70 mi. The pen controls a reference sphere projector which simultaneously plots the position on a chart 10 in. square. The ship can be turned at rates of up to 2 rpm by firing torque jets, and aiming trials have shown that the standard deviation of the main propulsion rocket motor is 1.65 deg. Some 20 flights have been made to determine a pilot's ability to carry out a simple circumnavigation of a luminous reference sphere 22 miles in diameter in the middle of a 700 mile square navigable area. Trials show that the ship cannot be flown successfully by direct instinctive interpretation of the projected display and it must be navigated from start to finish by deducing its position in space from the observations, plotting this on a chart, and taking the control action needed.

1,543 THE BIOLOGICAL SATELLITE (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959)
Haviland, R. P.
General Electric Co., Philadelphia, Pa.

This is a proposal for a biological satellite to investigate problems of weightlessness and radiation exposure. The conceptions of three different vehicles are given and the experiments possible are outlined. Specific research areas would include adaptation to zero-g; learning of locomotion under space; effect of exposure to energetic particles, and effect of photon radiation. Three classes of living subjects would be utilized: fruit fly (long term exposure to radiation); mice and rats (radiation effects on the organisms and future generations); tailless type primates (probably Rhesus monkey and chimpanzee) (radiation effects but mostly adaptability to zero-g).

1,544 **WHAT DO LUNAR TEMPERATURES TELL US CONCERNING THE NATURE OF THE MOON'S SURFACE?**
Heinz, Lettau
Gough, J., Jr., Translator
December 1955
Air Force Cambridge Research Center, Bedford, Mass.
(ASTIA AD 78,211)

The use of the temperature radiation of the Moon to compute the temperature of the Moon's surface, and thus to obtain information on the physical nature of the surface, is described.

1,545 **SOME CONSIDERATIONS OF SHAPE AND CONTROL FOR HYPERSONIC VEHICLES (Presented at the 7th Anglo-American Aeronautical Conference, New York, N.Y., October 5–7, 1959)**
Metcalfe, H.
Great Britain, Bristol Aeroplane Co., Ltd.
Institute of the Aeronautical Sciences, Inc.,
New York 21, N.Y.
IAS Paper No. 59-144

The aerodynamic design for hypersonic vehicles with special emphasis on stability and control is discussed in this paper. Compatability between the various requirements after satisfying the limits on design imposed by heating makes the choice of configurations a difficult one. The reason for using various shapes for different tasks is summarized.

1,546 **SPACE POWER (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959.)**
Crane, W. W. T.
Martin Co., Baltimore, Md.

This report maintains that safety packaged isotopic power supplies can be built during the next few years to produce eight watt/lb and at significantly higher efficiencies than 5 or 6%. It is contended that only four isotopes (Curium–242, Polonium–210, Curium–244 and Plutonium–238) have merit as heat sources.

1,547 **THE STERILIZATION OF SPACE VEHICLES TO PREVENT EXTRATERRESTRIAL BIOLOGICAL CONTAMINATION (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959.)**
Davies, R. W., and Comuntzis, M. G.
Jet Propulsion Laboratory, California Institute of Technology, Pasadena
External Publication 698

It is maintained that the introduction of terrestrial organisms and contaminants might so distort the biology of planets as to constitute a scientific catastrophe. It is believed feasible to sterilize probes so that loss of information to future investigators is minimized. Recommended methods are use of ethylene oxide, heat and radiation, accompanied by the sterile assembly of special components. Recommendations are made that pollution tolerance be kept to 10^{-8} dead bacteria per missile, and that infection tolerance be less than 10^{-6} per missile for the planets and 10^{-1} for the Moon.

1,548 **DIFFERENTIAL EXPRESSIONS FOR LOW-ECCENTRICITY GEOCENTRIC ORBITS (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959.)**
Herrick, S., Walter, L. G., and Hilton, C. G.
Aeronutronic Systems, Inc., Glendale

Differential expressions are derived that are applicable to correction of low-eccentricity orbits and the evaluation of uncertainty in the knowledge of the orbits.

1,549 **SECULAR VARIATION IN THE INCLINATION OF THE ORBIT OF EARTH SATELLITES (1957) AND AIR DRAG (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959.)**
Rowell, L. N., and Smith, M. C.
RAND Corp., Santa Monica, Calif.

A plausible explanation of this phenomenon is the component of drag acceleration normal to the orbital plane arising from the rotation of the Earth's atmosphere in the same sense as the satellite. This component causes the inclination of the orbital plane to decrease. Rate is found by equations.

1,550 **LUNAR EXPLORATION BY PHOTOGRAPHY FROM A SPACE VEHICLE (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959.)**
Davies, M. E.
RAND Corp., Santa Monica, Calif.

A panoramic camera which should get pictures superior to those obtained by telescope or TV is advocated. The camera would utilize the Lunar vehicle's spin stabilization to perform scanning. However, the vehicle would have to sense its spin rate and the approximate direction of the ground.

1,551 **EFFECTS OF A METEROID IMPACT ON STEEL AND ALUMINUM IN SPACE (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959.)**
Bjork, R. L.
RAND Corp., Santa Monica, Calif.

This paper is largely confined to estimating the effects of a collision between an individual meteoroid and some component of the vehicle. For example, iron/iron and aluminum/aluminum strikes are produced by projectiles 10 cm in both height and diameter traveling at 5.5 km (18,000 ft) per sec, and illustrations depict the shockwave progress after varying numbers of microseconds from first impact. It is finally concluded that metal shells may be expected to have useful lives about two orders of magnitude lower than previously supposed.

1,552 **IMPULSIVE MIDCOURSE CORRECTION OF AN INTERPLANETARY TRANSFER (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959.)**
Gunkel, R. J., Lascody, D. N., and Merrilees, D. S.
Douglas Aircraft Co., Inc., Santa Monica, Calif.
Engineering Paper No. 804

By surveying possible ballistic trajectories from Earth to another planet and paying attention to sensitivity to initial condition errors, it is indicated that initial condition tolerances can be maximized by careful choice of trajectory. The possibility of midcourse correction to compensate, and give the relationship between correction impulse requirements and sensitivity to initial conditions is considered. It is concluded that approximate methods are suitable for determining basic trends but there is a necessity for using more accurate solutions for design purposes.

1,553 **IONOSPHERIC SCINTILLATIONS OF SATELLITE SIGNALS (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959.)**
Hutchinson, H. P., and Arendt, P. R.
Army Signal Research and Development Lab., Fort Monmouth, N.J.

It is believed that techniques using doppler shift and direction-finding may prove to be most useful tools in further studies in the ionosphere and space. Short-time variations of satellite-emitted radio signals can give a good measure of the roughness or inhomogenity of the ionosphere. Variations are more noticeable at the low frequencies—20 and 40 mc—than at the higher ones, but the scintillations are not negligible at 10 mc, the frequency most commonly used for determining position of previous U.S. satellites.

1,554 **EMPIRICAL PARAMETERS DETERMINING THE LIFETIME OF ARTIFICIAL EARTH SATELLITES**
Wackernagel, H. B.
May 1959
Air Force Cambridge Research Center, Bedford, Mass., Space Flight Physics Lab.
AFCRC-TN-59-455

The decay of the orbit of most artificial Earth satellites can be described by the simple formula $\log N = R\,(\log \delta P_N + Q)$; N is the revolution number reckoned backwards from the revolution of decay, and δP_N is a quantity defined in the text. The parameters R and Q are correlated to the ratio m/F of mass and effective cross-section, and to the height of the perigee q, respectively.

1,555 **METHODS OF ANALYZING OBSERVATIONS ON SATELLITES (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959.)**
Groves, G. V., and Davies, M. J.
Great Britain, University College, London

A theory is developed for the precise determination of the elements of a satellite orbit from observational data. Account is taken of the effects of atmospheric refraction, aberration, the finite speed of light, and the difference between geocentric and geographic latitude.

1,556 **THE THREE-BODY PROBLEM: EARTH, MOON AND SPACESHIP (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959.)**
Grobner, W., and Cap, F.
Austria, Innsbruck University

The solution of the astronomical n-body problem using Lie series is discussed and the known algebraic integrals—conservation of momentum, angular momentum and energy—are reproduced. There is a thorough discussion of the initial data, the closed solution of the three-body problem is given, and two different methods for numerical computation are furnished.

1,557 **TRACKING OBJECTS WITHIN THE SOLAR SYSTEM USING ONLY DOPPLER MEASUREMENTS (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959.)**

Newton, R. R.
Johns Hopkins University, Applied Physics Laboratory, Silver Springs, Md.

It is assumed that an artificial planetoid emits radiation of reasonably stable frequency which can be received by an Earth tracking station. Without using any information except the time dependence of the doppler shift, orbital elements can be completely determined with a precision of about five significant figures, during one-half day's tracking from one station. The effective range for doppler tracking is thought to be at least 50 million km.

1,558 **RECENT DEVELOPMENTS AND DESIGNS OF THE ION ROCKET ENGINE (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959.)**

Boden, R. H.
Rocketdyne, Canoga Park, Calif.

An ion thrust device directed toward a prototype engine has been in operation at Rocketdyne for several months, producing quantitative measurements of thrust. There is a possibility of a flyable ion engine, delivering less than one lb of thrust and utilizing a propellant such as cesium, being available in five years.

1,559 **PERSONNEL SELECTION AND TRAINING FOR SPACE FLIGHT (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959.)**

Flickinger, D.
Air Research and Development Command,
Andrews AFB, Washington, D.C.

Recruitment and training of crews for manned orbital flight are discussed, and it is pointed out that the determination of an individual's psycho-physiologic fitness comprises a major task for the behaviorists, the physiologist and the flight surgeon. Medical evaluation, stress tolerance testing and indoctrination would require 18 months for each candidate.

1,560 **LAUNCHING CONDITIONS AND THE GEOMETRY OF ORBITS IN A CENTRAL GRAVITY FIELD (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959.)**

Sun, Fang-Toh
Taiwan, Taiwan Provincial Cheng Kung University, Tainan

Formulas relating the principal geometrical parameters of the orbit to the launching parameters at final burnout are developed. Treatment is given to the elliptic, the parabolic and the hyperbolic types of unperturbed orbit. The problem of burnout precision is briefly discussed, and an energy-momentum diagram shows the essential geometrical aspects of possible orbits in a single chart.

1,561 **THEORY OF THE *N*-STEP RELATIVISTIC ROCKET (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959.)**
Subotowicz, M.
Poland, Polish Astronautical Society, Warsaw

This paper presents the theory of the relativistic multistage rocket necessary for the far future flights to the stars. A differential equation describing mass and velocity changes is defined along with its optimization possibilities. It is accepted that all stages would be analagous and all engines would use the same jet mass. Such a stage rocket would have only one reaction chamber, used in turn by all steps.

1,562 **PROBLEMS OF MAGNETIC PROPULSION OF PLASMA (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959.)**
Waniek, R. W.
Giannini Plasmadyne Corp., Santa Ana, Calif.

This paper deals with theoretical problems and experimental results obtained during a study aimed at accelerating ionized gases by strong transient magnetic fields. Techniques of these fields are discussed with their possible applications to high-field plasma thrustors. Special air-core magnet configurations are shown and their characteristics as intermittent plasma propulsors are outlined. It is believed that such thrusts might likely have a useful place in future space vehicles.

1,563 **APPLICATION OF SOLID PROPELLANTS TO SPACE FLIGHT VEHICLES (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959)**
Thackwell, H. L. Jr.
Grand Central Rocket Co., Redlands, Calif.

Preliminary design calculations are given for a three-stage, all propellant vehicle called the *Envoy* which, when ground-launched, could send a 50-lb payload to the Moon or place a 230-lb payload into a 300-mi high orbit. The vehicle would weigh 17,000 lb and would be 37.8 ft high. It is anticipated that the *Envoy* would cost considerably less than the $500,000 figure for the *Scout* or $1,000,000 for a single *Thor* liquid booster.

1,564 **MINIMUM ENERGY REQUIREMENTS FOR SPACE TRAVEL (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959)**
Ruppe, H. O.
Army Ballistic Missile Agency, Redstone Arsenal, Ala.

The preliminary outline of an optimum vehicle and an approximation of the payload capability of a given vehicle are determined by calculating minimum energy requirements for space missions.

1,565 **MEASUREMENT OF *JUPITER* RE-ENTRY RADIATION (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959)**
Woodbridge, D. D., and Arnquist, W. N.
Army Ballistic Missile Agency, Redstone Arsenal, Ala.

This is a detailed report on the Army's "Operation Gaslight," the name given to the re-entry radiation measurement program of ABMA. Through industry participation, preliminary radiometric and photographic measurements have been made from the PbS infrared limit to the near ultraviolet. Extensions to cover the 3–5 micron band are in progress. Re-entry velocities begin at about Mach 14, which corresponds to an adiabatic shock front temperature of nearly 4000°K. Difficulties of operations are mentioned and the coordination of instruments at several locations with timing circuits is described.

1,566 **DETERMINATION OF AIR DENSITY AND THE EARTH'S GRAVITATION FIELD FROM THE ORBITS OF ARTIFICIAL SATELLITES (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959)**
King-Hele, D. C.
Great Britain, Royal Aircraft Establishment

Taking into account the oblateness of the Earth and atmosphere, the tumbling of satellites and rotation of the atmosphere, methods are given for evaluating density at heights between 200 and 400 km. Variation of density is traced with time.

1,567 **ON THE APPARENT MOTION OF AN EARTH'S ARTIFICIAL SATELLITE (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959)**
de Orus, J. J.
Spain, Fabra Observatory, Barcelona

It is pointed out that a primary problem in radio observations of an artificial satellite is determining the time when the satellite is at its minimum distance from a determined Earth station. This time calculation is simplfied owing to the feeble flattening of the terrestrial globe and the slight relation between the periods of revolution of the satellite and the Earth's rotation.

1,568 NUCLEAR ROCKET MISSIONS AND ASSOCIATED POWER PLANTS (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959)
Newgard, J. J., and Levoy, M. M.
Thiokol Chemical Corp., Reaction Motors Division, Denville, N. J.

Requirements of open-cycle nuclear power plants for a number of terrestrial escapes to orbit and space missions are given. Missions analyzed include single-stage, large payload, nuclear boosted escape vehicles; chemically boosted second-stage nuclear rockets escaping with large payloads, and terrestrial orbiting nuclear vehicles capable of moving into far space. Important is the analyzation of a "family" of hydrogen cooled, solid-fuel graphic element, graphite core moderated, BeO reflector-moderated reactor power plants.

1,569 THE SATELLITE 1959 GAMMA (*DISCOVERER II*): A PRELIMINARY ANALYSIS
Wackernagel, H. B.
August 1959
Air Force Cambridge Research Center,
Bedford, Mass., Space Flight Physics Lab.
AFCRC-TN-59-457 (GRDST-7)

This report contains preliminary results of a study of the orbital motion of the satellite 1959 Gamma, the second in the *Discoverer* series. The entire lifetime of the object is considered. The orbit of this satellite showed two new features, for which no information existed before. The two peculiarities are the very small eccentricity and the inclination near 90 deg (polar orbit).

A catalogue of the observations is given in the Appendix.

1,570 ACCURACY LIMITS IN ELECTRONIC TRACKING OF SPACE VEHICLES (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959)
von Handel, P. F., and Hoehndorf, F.
Air Force Missile Development Center,
Holloman AFB, N. M.

It is predicted that the general trend of further developments in tracking space vehicles will shift toward electronic procedures which promise to achieve the same accuracy without restrictions on weather conditions and time of the day.

Pointing out that electronic tracking of objects moving in the atmosphere is limited by propagation anomalies; i.e., limiting use of high-precision systems, frequencies in the kilo megacycle range were recommended.

1,571 THE TECHNICAL REALIZATION OF SUBGRAVITY AND WEIGHTLESSNESS (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959)

Wolczek, O.
Poland, Polish Academy of Sciences, Warsaw,
Institute for Nuclear Research

It is suggested that an effective way of obtaining smaller gravitation and weightlessness on Earth for hours, or longer, could be by centrifuges or devices operating on the same basis. Such devices would be stationed in a vertical position so their axis of rotation would be paralleled to the Earth's surface. Equipment would first serve to investigate force effects on small objects; i.e., construction materials, miniaturized measuring apparatus, and smaller experimental animals such as mice.

1,572 INTERPLANETARY HOMING (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959)

Sterns, E. V.
Lockheed Aircraft Corp., Missiles and Space Division
Sunnyvale, Calif.

A closed-loop system of instrumentation was proposed for control of vehicle trajectory to give necessary thrust control to place space vehicles in a suitable orbit for final approach. Midcourse trajectory based on knowledge of probable guidance and control accuracies will have a probable error of about 100,000 mi. As such, it must be brought into a landing corridor that is about 10 mi wide at periapsis, taking into account the strong influence of the destination planet's gravity field. An interplanetary sextant was proposed for the homing task.

1,573 PREDICTION OF MAN'S PERFORMANCE IN SPACE USING FLIGHT SIMULATORS AND BALLOON-BORNE SYSTEMS (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959)

Vaeth, J. G.
Advanced Research Projects Agency,
Washington, D. C.

It is proposed that development of advanced forms of ground-based flight simulators and use of long-endurance, high-altitude, manned balloon flights may determine capability of men to perform in space. By comparing measurements with corresponding data on the ability of automatic equipment to do the same, it would be possible to specify and predict those tasks which can be achieved better by manned than unmanned space systems.

1,574 **"GREEN" AREAS OF MARS AND COLOR VISION (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959)**
Schmidt, I.
Indiana University, Bloomington

To determine whether the dark areas on the planet are real or not, production of contrasts was studied experimentally by using colored papers simulating the bright and dark areas. It was deduced that a contrast induction is possible on the surface of Mars, depending on hue, brightness, and saturation of contrast-inducing and contrasting area. It is recommended that an insulation observation of dark areas be used as a means which may be helpful in deciding the real nature of the "green" areas of the plant.

1,575 **MAGNETOHYDRODYNAMICS AND ITS APPLICATION TO PROPULSION AND RE-ENTRY (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959)**
Meyer, R. X.
Space Technology Laboratories, Los Angeles, Calif.

The first part of this paper is largely a review of some of the basic concepts of magnetohydrodynamics in continuum fluid mechanics. The theory of the Newtonian approximation to flow is developed in the second part of the paper. Results are presented concerning flow in the shock layer of a re-entry body, and a similarity solution of equations is given for a circular cone in the case of finite and variable electric conductivity.

1,576 **RE-ENTRY PATHS FOR MANNED SATELLITES (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959)**
Hilton, W. F.
Great Britain, Hawker Siddeley Aviation, Ltd.

It is suggested that "high-drag plus high-lift" vehicles be used for manned re-entry, and the "high-drag with zero-lift" vehicles be reserved for simple unmanned re-entry, or very early manned flights.

A design study is being carried out at Sir W. G. Armstrong Whitworth Aircraft Ltd. (part of Hawker Siddeley) for a complete project to put two men into orbit (apogee 680 mi, perigee, 80 mi) and for them to land safely back on Earth. Calculations were made to determine the most economical method of achieving a given change of orbit. A report showed that acceleration towards the Earth at perigee does not bring the satellite any nearer to the Earth, but results in rotation of the axis of the ellipse. It was determined that a small rocket producing 1 g for 1 sec at apogee will lower the perigee height by about 20 mi.

1,577 **MOTION OF AN ORBITING VEHICLE SUBJECT TO CONTINUOUS RADIAL THRUST, INCLUDING A STUDY OF PLANETARY ENCOUNTERS (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959)**
Paiewonsky, B.
Princeton University, N. J.

Use of radial thrust for braking spaceships in planetary encounters is investigated, using one-dimensional potentials. It is pointed out that use of radial braking will produce an increase in the perigee altitude compared with the perigee of the coasting path, a generally desired result. However, due to the extreme sensitivity of predicted perigee distance in close approaches to planets, en route measurements of the navigation and guidance equipment for both a radial-braking system and the impulsive thrust-correction system will require the same high degree of accuracy. It is concluded that one system does not seem to have any overwhelming advantage over the other.

1,578 **SOME NEW METHODS OF SATELLITE ORBIT CALCULATIONS AND STABILITY PROBLEMS (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959)**
Knothe, H.
Air Force Missile Development Center, Holloman AFB, N. M.

Equations of motion for a satellite in a rotationally symmetric gravity field are reduced to systems of ordinary first order differential equations. A rapidly convergent process of iteration for solving these equations is explained and examples are given. A differential geometrical approach giving formulae for the calculations of regression is supplied.

1,579 **DESIGN STUDY OF AN EARTH SATELLITE EVOLVING FROM A FOUR-STEP SOLID PROPELLANT ROCKET VEHICLE (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30–September 5, 1959)**
Kumar, S. K., and Rau, B. R.
India, Indian Astronautical Society, Mysore

It is pointed out that countries such as India cannot afford large-scale liquid-propellant rocket research, and that any progress or contributions from such countries in space exploration will have to be through solid-propellant rockets. This is not keeping the nation from a novel space exploration approach.

While planning for launching a 50-kg satellite, it is desirable to place a solid-propellant rocket on top of the satellite section, which would be intended to escape the Earth after the satellite has gone into orbit. This experiment would show the possibility of orbital launching.

1,580 MATERIALS VULNERABILITY TO SPACE RADIATION
Goodwin, J. M.
1959
General Electric Co., Philadelphia, Pa., Aerosciences Lab.
Paper

This report is a review of the present knowledge of space environment radiation fields and the effect of this radiation on materials. Of particular interest are the Van Allen Radiation Belts (which are still largely undefined as to altitude and magnitude) and space radiation effects on materials presently used in the Earth satellite programs, as well as potential space-vehicle materials.

1,581 SOME ASPECTS OF THE DESIGN OF METEOROID BUMPERS
Dow, N. F.
1959
General Electric Co., Philadelphia, Pa., Aerosciences Lab.
Paper

A semi-empirical formula based on the work of Kornhauser is derived for the design of a meteroroid bumper. The bumper considered is in the form of a relatively thin shell mounted externally on the wall to be shielded.

Sample calculations with representative values for the constants employed in the formula show that if the equations have any meaning they may suggest that the bumper should be made of a low-density material, that optimum bumper thickness (or equivalent thickness on a weight basis) is less than half the crater depth in an unprotected wall, and that a multiple-walled shield should be better than a double wall.

1,582 LEAST-WEIGHT DESIGN AND CONFIGURATION FOR SPACE-VEHICLE STRUCTURES
Dow, N. F.
April 10, 1959
General Electric Co., Philadelphia, Pa., Aerosciences Lab.
Paper

A study is made of a number of aspects of the design of space-vehicle structures. Possibilities of weight savings are shown for: (1) intersecting-sphere pressure vessels, (2) multiple-wall meteoroid shields, (3) pure monocoque or ring-stiffened construction to prevent explosive decompressions, (4) properly tapered or pressure-stabilized outriggers, and (5) the sphere-on-a-string configuration to provide an artificial gravity. Because of the importance of structural weight, each of the examples helps to indicate that structural considerations must have a strong influence on the configuration or architecture of space vehicles.

1,583 RELIABILITY OF INTERPLANETARY AND LUNAR ORBIT COMPUTATIONS
Szebehely, V. G.
1959
General Electric Co., Philadelphia, Pa., Aerosciences Lab.
Paper

A simple method is presented for determining the accuracy and reliability of computer solutions of interplanetary and lunar orbit problems. The method compares the analytical solution of a simplified problem with the corresponding computer result. The simplification preserves the restricted three-body character of the problem and it is applicable to the Earth-Moon-Vehicle, to a Planet-Planet-Vehicle, or to a Planet-Sun-Vehicle system. The analytical solution permits the estimation of the effect of the "perturbing" body on the orbit. The geometric and dynamic characteristics of the actual orbit are easily determined. The simplified analytical solution is presented to check computer solutions and not to replace them, since it requires a fixed system of force centers.

1,584 MEASUREMENTS OF VELOCITY AND MOMENTUM WITH A PULSED T-TUBE PLASMA GENERATOR
Gorowitz, B., and Harned, B. W.
February 20, 1959
General Electric Co., Philadelphia, Pa., Aerosciences Lab.
Paper

In preliminary studies concerning the use of plasma acceleration for propulsion purposes, a series of measurements has been made of velocity and momentum of plasma bursts, both in single-shot and pulsed operation, over a range of pressures and input energies for various magnitudes and directions of magnetic field at the gaseous discharge. The effect of magnetic field on acceleration of the plasma and its contribution to the momentum transferred to a ballistic pendulum are discussed. Extrapolation has been made of power input for the small thrust obtained to that required for a one-pound thrust over the range of pressures and efficiencies investigated.

1,585 A PARTIALLY CLOSED CYCLE LIFE-SUPPORT SYSTEM FOR LONG TERM SPACE FLIGHT
Konikoff, J. J.
1959
General Electric Co., Philadelphia, Pa., Aerosciences Lab.
Paper

An evaluation is made of the current state of the art for controlling the internal environment of manned space vehicles. It is shown that, as flighttime increases, it becomes important to introduce new methods so that an approach to the closed-cycle ecological concept can be attained. Otherwise, weight penalties, resulting from the prestoring of man's needs, become severe.

A partial closed-cycle system is presented, incorporating several novel approaches that appear potentially feasible in regenerating man's wastes into potable water and oxygen while maintaining a purified atmosphere.

The over-all approach is presented in a system concept to indicate the interrelations existing between the various processes, and it is recommended that further study and experimentation be undertaken.

1,586 PHOTOGRAMMETRIC DETERMINATION OF THE ROCKET TRAJECTORY OF THE INFLATED BALLOON SATELLITE (AM-19B)
Schmid, H. H.
August, 1959
Ballistic Research Laboratories, Aberdeen Proving Ground, Md.
Technical Note 1273

A time-coded trail of a portion of the trajectory of the rocket associated with the "Inflated Balloon Satellite Experiment," launched on August 14, 1959, was recorded on a BC-4 photogrammetric theodolite, together with time-coded star trails. The direction, as a function of time, has been determined for a number of points on the trajectory of the rocket, as observed from the Spesutie Island calibration pier.

1,587 AN INTERPLANETARY TRAJECTORY PROGRAM
Conte; S. D., Gregory, R. T., Mercer, R. J., and Titus, J.
October 8, 1959
Space Technology Laboratories, Los Angeles, California
PA/1969-01

To compute the trajectory of a vehicle from the Earth to the planet Mars, or the planet Venus, the equations of motion are derived with the assumption that the motion of the vehicle is influenced only the gravitational fields of the Earth, Moon, Sun, Venus, Mars and Jupiter.

The problem consists of three phases: During the first phase the influence of the Earth-Moon system is greater than that of the Sun or of the other planets and consequently a geocentric coordinate system is used. During the second phase the influence of the Sun is predominant, hence, a heliocentric coordinate system is used. Finally, during the third phase, the target planet (Mars or Venus) has the greatest influence on the motion of the vehicle and so a planetocentric coordinate system is used.

1,588 NATURAL ENVIRONMENT OF THE PLANET VENUS
Shaw, J. H., and Bobrovnikoff, N. T.
Ohio State University Research Foundation, Columbus
February 1959
Wright Air Development Center, Wright-Patterson AFB, Ohio
WADC Phase Technical Note 2

This report summarizes the present knowledge of the physical environment of the planet Venus. There are many aspects of this environment which are imperfectly understood at the present time because of the absence of adequate observational data. Attempts are made to estimate the probable environment in cases where it cannot be definitely established.

1,589 **INFORMATION ON SOVIET BLOC INTERNATIONAL GEOPHYSICAL COOPERATION—1959**
August 21, 1959
U. S. Department of Commerce, Washington, D. C., Office of Technical Services
PB 131632-80

Part I. Rockets and Artificial Earth Satellites

The design, propulsion launching, guidance, and flight-path monitoring are all discussed in this translation.

Part II. Upper Atmosphere

The density and content of interplanetary space is evaluated by correlating scattered pieces of information obtained from infrared spectra, magnetic-field studies, and research-rocket experiments.

1,590 **DETECTION AND ANALYSIS OF RADIO SIGNALS FROM SPACE VEHICLES**
Frost, A. D., and Melvin, D. W.
June 15, 1959
New Hampshire, University of, Durham, Antenna Systems Lab.
Scientific Report No. 1
AFCRC-TN-59378 (ASTIA AD-217,858)

Facilities have been set up for the measurement of the doppler shift in the received radio signals from Earth satellite vehicles as part of a multi-station doppler tracking technique. Perturbations due to modulation or ionospheric distortion in the signals from *1958 Delta* and *1959 Epsilon* have caused the experiments to be inconclusive. A frequency measurement technique applicable to pulsed or fading signals is described. Work is now in progress on the development of parametric amplifiers in microwave strip line form.

1,591 **ACHIEVEMENTS OF SOVIET ASTRONOMY**
Vorontsov-Vel'yaminov, B. A.
May 20, 1959
U. S. Joint Publications Research Service, Washington, D. C.

This translation contains a history of the science of astronomy in the USSR. Some of the subjects considered are: practical application, planets and comets, the Sun, variables and novae, nebulae and structure of the universe, new astronomy instruments, and the origin of celestial bodies.

1,592 **SOME PROBLEMS OF ROUND-TRIP MANNED FLIGHT OUTSIDE THE EARTH'S ATMOSPHERE (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)**
Hiatt, E. P.,
Wright Air Development Center, Wright-Patterson AFB, Ohio, Aero-Medical Lab.
American Astronautical Society, Palo Alto, Calif.
58-1

A review is given of the present status of research on means of reducing the hazards of manned spaceflights, considering such factors as respiration, pressure, temperature, communication, nutrition, toxic agents, acceleration, and psychic factors, with special attention to the last two.

1,593 **TIME—ACTIVITY—ENVIRONMENT ANALYSIS: A WAY OF PLANNING FOR HUMAN SPACE FLIGHT (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)**
Magelsdorf, J. E.
Lockheed Aircraft Corp., Missiles and Space Division, Sunnyvale, Calif.
American Astronautical Society, Palo Alto, Calif.
58-2

Adequate planning for manned spaceflight requires a systematic means of handling the relatively large number of considerations upon which mission success depend. In a space vehicle, man is expected to be maintained in sound physical and mental health, and to perform certain tasks. Whether these expectations are realized will depend upon man's compatibility with the environment. This compatibility may be accomplished by an iterative method to be described which uses time as a common denominator against which to correlate the parameter of environment (temperature, humidity, pressure, g-forces, isolation, acoustic noise, etc.)

1,594 **MANNED CABIN SURFACE TEMPERATURES AND HEAT TRANSFER RATES FOR A RE-ENTRY HYPERSONIC GLIDE VEHICLE (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)**
Mouritsen, T. E.
Chance Vought Aircraft, Inc., Dallas, Texas
American Astronautical Society, Palo Alto, Calif.
58-3

Recognizing the interest in orbiting and hypersonic glide vehicles and, more specifically, the manned version of such vehicles, the problem of maintaining a suitable cabin environment during re-entry has attracted considerable attention. Prior to re-entry, the orbiting vehicle is subjected to a periodical surface temperature variation in the range of 70°F to 140°F. Upon initiation of re-entry to the atmosphere, the exterior surface temperatures increase due to aerodynamic heating. Cabin heat input and cabin fuselage outside surface temperatures were estimated for a hypersonic glide vehicle based on a flight profile, and vehicle characteristics were considered feasible. The flight profile was selected in such a manner that the maximum uncooled external fuselage temperatures would be compatible with the materials used. The heat transfer rates through the cabin fuselage walls, and the cabin interior surface temperatures, were estimated for a range of reasonable heat-transfer coefficients during the period of re-entry. Curves are presented of the approximate flight profile utilized, radiation-equilibrium temperatures of surfaces during re-entry, and heat transfer through the fuselage walls. These results may be considered typical of the thermal performance of a hypersonic glide vehicle. While variations in flight conditions, cabin surface area, surface temperatures, and flight time will affect the heat loads and temperatures encountered, these results may be used as an estimation of the range of cabin heating loads and fuselage temperatures that would be encountered by a hypersonic glide vehicle during return to Earth from orbit.

1,595 MAN'S OPERATIONAL ENVIRONMENT IN SPACE (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)
Hoover, G. W.
U. S. Office of Naval Research, Washington, D. C.
American Astronautical Society, Palo Alto, Calif.
58-4

This paper deals with the requirements for an operational environment for manned space vehicles. It discusses man's tasks as a decision maker, and the instrumentation and controls required for man to perform in this capacity.

1,596 SATELLITE PROPULSION SYSTEMS (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)
Corliss, W. R., and Zipkin, M. A.
General Electric Co., Flight Propulsion Lab., Cincinnati, Ohio
American Astronautical Society, Palo Alto, Calif.
58-5

Contemporary satellites possess no inherent mobility. The larger, more sophisticated satellites of the future will require a propulsion system to attain their peaceful and military objectives. In this paper the propulsion system performance requirements are estimated for a variety of anticipated satellite missions. Minimum acceptable thrust-to-weight ratios and specific impulses are established for a range of satellite sizes for such maneuvers as orbit trimming, orbit changing, attitude control and drag make-up. Such maneuvers would be characteristic of astronomical, meteorological, and early warning surveillance satellites. From these performance requirements, it is possible to select the proper space propulsion systems for the missions by matching the requirements with the estimated capabilities of the wide range of propulsion systems available. The systems examined include chemical and nuclear rockets. The characteristics of these propulsion systems are delineated and their applicability to satellite missions is reviewed.

1,597 **ELECTROMAGNETIC "PINCH EFFECT" AS A SPACE PROPULSION SYSTEM (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)**
Kunen, A. E.
Republic Aviation Corp., Farmingdale, N. Y.
American Astronautical Society, Palo Alto, Calif.
58-6

Experiments for controlled thermonuclear fusion suggest a new propulsion principle for spaceflight. An electrical discharge produces a cylindrical construction of a column of gas between two electrodes, the so-called "pinch effect." Velocities of the constricted ionized gas (plasma) exceeding 100,000 ft/sec have been reported. This paper describes and discusses the applications of the pinch effect to space propulsion. The problems and possible solutions of any electrical-plasma propulsion system for spaceflight are considered.

1,598 **LABORATORY EXPERIMENTS IN HYDROMAGNETIC PROPULSION (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)**
Gauger, J., Vali, V., and Turner, T. E.
Lockheed Aircraft Corp., Missile and Space Division
Sunnyvale, California
American Astronautical Society, Palo Alto, Calif.
58-7

Propulsion systems utilizing magnetohydrodynamic effects may well be of value for space vehicles. Several techniques have been proposed for such systems. This paper describes experiments being conducted on capacitor discharge shock tubes which yield shock velocities up to 6 cm/μsec in air, or specific impulses near 6000 sec. These shocks are produced by discharging a large bank of energy-storage capacitors through an electrode system designed to use the magnetic energy associated with the discharge currents. The dependence of shock velocity on the energy of the capacitor system, driving currents during the discharge, and ambient pressure in the shock tube will be discussed.

1,599 **SOME DESIGN ASPECTS OF AN INTERPLANETARY EXPLORATORY VEHICLE (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)**
Hebeler, H. K., and White, R. D.
Boeing Airplane Co., Seattle, Washington
American Astronautical Society, Palo Alto, Calif.
58-8

A vehicle, launched from an Earth-bound satellite for an unmanned reconnaisance mission to Mars, is described, and justification is indicated for the selection of powerplant, navigation and control means, as well as data-taking and transmission methods. Low-load factors, rigidity considerations, and an environment with radiation and particle hazards require severe design compromises for extraterrestrial vehicles. Design arrangements and techniques, including diaphragm and tension-wire structure, are considered in view of design lives which must be measured in years rather than hours. Material selection is based on minimizing the weight in view of thermal and meteorite problems.

1,600 **STRUCTURAL ASPECTS OF EARTH GLIDE RE-ENTRY VEHICLES (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)**
Braun, M. T., and Czarnecki, E. G.
Boeing Airplane Co., Seattle, Wash.
American Astronautical Society, Palo Alto, Calif.
58-9

A vehicle, re-entering the Earth's atmosphere from orbital flight, is analyzed from temperature considerations. The general aspects of resulting thermal stresses and material limitations are discussed. Finally, a design arrangement for the successful solution of the structural engineering problem using presently available techniques and materials is presented.

1,601 **TECHNIQUES IN THE PREDICTION OF SPACE-VEHICLE RELIABILITY (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)**
Youtcheff, J. S., and Karmiol, E. D.
Air Force Missile Development Center, Holloman AFB, N. M.
American Astronautical Society, Palo Alto, Calif.
58-10

As in all complex systems, space-vehicle reliability is essential in the attainment of the operational objectives. However, the uniqueness of spaceflight imposes reliability considerations and requirements which are equally unique. In determining the adequacy of the space vehicle to meet these requirements, techniques can be employed to predict space-vehicle reliability, utilizing methods developed in ballistic missile reliability programs. This paper discusses the space-vehicle operational and environment problems and the techniques that can be employed to predict the probability of successful performance.

1,602 **SPACE-TO-SPACE PROPAGATION PHENOMENA (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)**
Lee, C. N.
Lockheed Aircraft Corp., Missiles and Space Division, Sunnyvale, Calif.
American Astronautical Society, Palo Alto, Calif.
58-11

The use of radio frequencies in the medium-frequency and high-frequency portions of the electromagnetic spectrum for space-to-space communication can take advantage of the considerable degree of shielding provided by the Earth's ionosphere from unintentional interference by ground-based radio equipment. However, the use of a frequency in the range mentioned gives rise to large magnitude propagation phenomena, such as multipath transmission frequency dispersion, attenuation and Faraday effect with their consequent effects on the signals. Theoretical investigations of ionospheric shielding and the attendant propagation phenomena are presented along with numerical results for the frequency range of 0.3 to 50 mc.

Computations using ionospheric models based on statistical critical frequency data and Chapman ionospheric layer theory along with a simplified ray-theory treatment have given the variation of power absorption and divergence attenuation with frequency for a 0-90 deg range of angles of arrival both at the Earth's surface and at a point in space. As a result, average cones of acceptance within which the space-ground attenuation is less than some prescribed value required for adequate isolation can be defined as functions of frequency. Outside of these cones of acceptance it would not be possible to interfere with the transmission.

Operation in the medium-frequency or high-frequency regions, however, introduces several difficulties in connection with the space-to-space transmission, the most important of which are (1) multipath effects, (2) frequency dispersion, (3) attenuation, and (4) Faraday effect. According to the best information available at the present time, considerable electron concentrations exist at very high altitudes (600-6000 electrons/cc). As a result of the relatively high electron concentration, transmission in the MF-HF region results in the same type of propagation effects associated with transmission from space-to-ground through the ionosphere.

Two types of inter-satellite attenuation have been studied: power absorption by electron-neutral molecule collisions and divergence attenuation due to refraction.

As a result of the Faraday effect, which is caused by a resonant coupling between the transmitted electromagnetic wave and the precession of electrons about the magnetic field lines (Larmor precession), double refraction effects occur. The computations deal with the relative phase shifts and difference between signal velocities of the ordinary and extraordinary rays of magneto-ionic theory, the effect of the relative phase shifts upon the wave polarization, and the production of multiple pulses due to the difference of signal velocities.

1,603 PRELIMINARY ANALYSIS OF SATELLITE OBSERVATIONS
(Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)
Garriott, O. K.
Stanford University, Stanford, Calif.
Electronic Research Laboratory
American Astronautical Society, Palo Alto, Calif.
58-12

Within the last year a new tool has become available for the study of the upper atmosphere, namely, the artificial Earth satellite. The signals from the Russian satellites are currently of most use for ionospheric investigation since the effect of the ionosphere is more pronounced at the lower frequencies.

The transmissions are received on antennas of several polarizations and recorded on a six-channel paper-tape machine. From these measurements the down-coming polarization can be determined and the effects of body motion and Faraday rotation separated. The frequency of the received signal is measured as a beat with a local crystal oscillator whose frequency is accurately determined by comparison with a secondary standard. The second harmonic of the satellite transmitter is frequently observed by the same method and both frequencies recorded on adjacent channels on magnetic tape.

A preliminary analysis of the *Sputnik III* data indicates the existence of very little satellite body motion, unlike previous *Sputniks* and the US satellites, which simplifies the determination of the ionospheric effects. The data also provide estimates of integrated electron density and some information on ionospheric irregularities. Antipodal signals which arrive while the satellite is near the point on the globe diametrically opposite the receiver are sometimes observed. A possible explanation may be found in tilt-mode propagation.

1,604 SATELLITE FARADAY EFFECT OBSERVATIONS (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)
Moe, C. R., and Bennion, J. L.
Lockheed Aircraft Corp., Missiles and Space Division, Sunnyvale, Calif.
American Astronautical Society, Palo Alto, Calif.
58-13

Various electromagnetic wave propagation phenomena may occur upon transmission of energy from a satellite to a ground receiving station. Various recordings of *Sputnik III* have been examined to determine what the more significant effects may be. Comparison of the 40-mc harmonic recordings with the 20-mc fundamental, and examination of the diurnal variation, indicates that the most prominent characteristic can be attributed to the Faraday effect. An estimate of the integrated electron density along the ray path is derived from these measurements.

1,605 SPACE COMMUNICATION LIMITS OF LOW NOISE RECEIVERS (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)
McCoy, C. T.
Philco Corp., Philadelphia, Pa.
American Astronautical Society, Palo Alto, Calif.
58-14

The alternate receiver sensitivity is achieved by elimination of noise sources within the receiver, and avoidance of those external to it. These sources are discussed in theory and practice as an aid to receiver design for space-communication distances of km to light years, and frequencies from one mc to gamma rays. For noise sources within receivers, comparisons are made of capabilities of receiver types: vacuum tube, traveling wave, cooled crystal, masers, parametric. Noise sources external to the receiver which are discussed are aurora, galactic, Sun, ionosphere refraction. Absorption by water in the atmosphere is also shown. A clarification of receiver noise-sensitivity terms will be made, showing the relationship between noise figure and sensitivity, and the units of power, power ration, degrees Kelvin, and decibels.

1,606 **FLAME ATTENUATION OF RF SIGNALS (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)**
Schmelzer, R. J.
Lockheed Aircraft Corp., Missiles and Space Division, Sunnyvale, Calif.
American Astronautical Society, Palo Alto, Calif.
58-15

After defining the problem of microwave propagation through rocket exhaust flames, the effect of flame expansion in the low-ambient pressure of high altitudes is described. Total attenuations through a typical flame are obtained by a simple analysis. With an antenna located far forward on a rocket, the attenuation is, at most, a few decibels. However, with an antenna located near the exit of the rocket engine, the attenuation may be a hundred times as great. The validity of the assumptions made is discussed.

1,607 **A REPORT ON THE FIFTH ASSEMBLY OF THE COMITÉ SPECIAL de l'ANNÉE GÉOPHYSIQUE INTERNATIONALE (CSAGI); MOSCOW STATE UNIVERSITY, MOSCOW, U.S.S.R., JULY 30–AUGUST 10, 1958 (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)**
Peterson, A. M.
Stanford University, Palo Alto, Calif., Electronic Research Lab.
American Astronautical Society, Palo Alto, Calif.
58-16

1,608 **NEXT—MANEUVERABLE SATELLITES? (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)**
Kelber, C. C.
Northrop Corp., Beverly Hills, Calif.
American Astronautical Society, Palo Alto, Calif.
58-17

The problem of orbit eccentricity control for rendezvous, evasion, or interception is considered. The application of small radial forces to the orbiting body is shown to be capable of producing large effects in relatively short times. Small radial forces alternating inward and outward each half revolution, although resulting in initially unbalanced radial accelerations of only 10^{-3} or 10^{-4} g, produce changes in total satellite excursion of 2 to 25 nautical mi/hr. Advantages of such capability are discussed, as well as alternative methods for achieving it, and areas of application for each. The insertion or removal of orbit eccentricity for purposes of controlling satellite lifetime and providing capability for rendezvous, evasion, or interception is concluded to be prerequisite to the practical application of satellites to military missions and/or ventures.

1,609 SATELLITE ORBITS AND INTERORBITAL TRANSFER (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)
Dobrowolski, A.
General Electric Co., Flight Propulsion Lab., Cincinnati, Ohio
American Astronautical Society, Palo Alto, Calif.
58-18

Based on the work previously done in the field of orbit perturbations, the effects of thrust in various directions, as well as perturbations by the Sun and Moon, the ablateness of the Earth and atmospheric contact are examined. The criteria for takeoff from satellite orbit for the initiation of an orbital transfer are established. A graphical survey of important parameters for interplanetary voyages is given.

1,610 ORBITAL MECHANICS OF SATELLITES (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)
Gedeon, G. S.
Chance Vought Aircraft, Inc., Dallas, Texas
American Astronautical Society, Palo Alto, Calif.
58-19

The problem associated with placing a satellite into a particular orbit, either from a boost trajectory, or from another orbit, can be solved by well-known equations. However, the solutions are often cumbersome due to the transcendental nature of the equations. In this paper a set of explicit relations is presented, which permits the direct solution of the problem of either determining the orbit from a given set of initial conditions, or of determining the initial conditions required to obtain a given orbit. These relations are presented on charts for convenience. Also treated is the problem of transfer between elliptic orbits which do not intersect. The treatment is a generalization of the Hohman transfer ellipse problem in the sense that the initial and final conditions are not concentric circles, but rather, confocal ellipses with skewed axes. The numerical examples, which were obtained with high-speed digital computers, show that the orbiting target can be intercepted only if the interceptor and the target are in proper juxtaposition. The conditions for proper juxtaposition are discussed.

1,611 **OPTIMAL TRANSFER BETWEEN TWO COPLANAR TERMINALS IN A GRAVITATIONAL FIELD (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)**
Vargo, L. G.
Space Technology Laboratories, Systems Evaluation Dept., Hawthorne, California
American Astronautical Society, Palo Alto, Calif.
58-20

An iterative method is derived which gives, to any desired degree of accuracy, the optimal mode of transfer between two planar terminals in the radial position-velocity space of a simple gravitational field. An optimal transfer implies the determination of initial and final thrust impulses which minimize the characteristic velocity (sum of the velocity increments produced by the impulses) of the mission. Other criteria are considered and their corresponding solutions outlined. The method is illustrated by a numerical example. The resulting minimum characteristic velocity is then compared with those for the non-optimal cases of cotangential and semielliptic paths. It is shown that a first-order approximation to optimal transfer may be expressed in closed form and often suffices for preliminary performance calculations.

1,612 **COLLISION TRAJECTORIES IN THE THREE-BODY PROBLEM (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)**
Benedikt, E. T.
Douglas Aircraft Co., Inc., Santa Monica, Calif.
American Astronautical Society, Palo Alto, Calif.
58-21

The connection between the analytical regularity of the trajectory of a missile moving under the action of two attracting masses (in practice the Earth and Moon, or the Sun and a planet) and the collision between the missile and the center of one of the bodies is noted. By applying a transformation due to T. Levi-Civita, it is possible to regularize collision trajectories, and to obtain conditions which the position and velocity of the missile must satisfy, at a point sufficiently near an attracting body, in order that the trajectory of the missile will pass through the center of the body.

1,613 **TEMPERATURE EQUILIBRIA IN SPACE VEHICLES (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)**
Cornog, R. A.
Space Technology Laboratories, Los Angeles, Calif.
American Astronautical Society, Palo Alto, Calif.
58-22

The equilibrium temperature reached within a space vehicle moving within the solar system is discussed. The effects of vehicle configuration, vehicle attitude, surface properties, and internal heat releases are evaluated and presented in the form of graphs. Particular attention is given to methods of vehicle design whereby, within wide limits, the equilibrium temperature can be set at any desired value.

1,614 **INTERPLANETARY DUST DISTRIBUTION AND EROSION EFFECTS (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)**
Beard, D. B.
California, University of, Davis
Lockheed Aircraft Corp., Missiles and Space Division
Sunnyvale, Calif.
American Astronautical Society, Palo Alto, Calif.
58-23

The presence and extent of minute material distributed throughout the solar system is inferred from observations of the outer solar corona and the brightness of the night sky. Calculations based on the observations show in an unambiguous way, that the dust concentration decreases with increasing solar distance as about $r^{-1.5}$ where r is the solar distance. The density of particles depends inversely on the particle radius to roughly the 3.5 power. Considerations of the orbits of particles in the combined gravitational fields of the Sun and the planets and the observations themselves show concentrations of the dust in the plane of ecliptic and in the region of the planets. Roughly 10^{-5} to 10^{-6} particles larger than 4 microns should impact cm^2/sec on a satellite skin. This figure is in agreement with the direct observations made with *Explorer I.*

1,615 **A NEW INSTRUMENT FOR MEASURING ATMOSPHERIC DENSITY AND TEMPERATURE AT SATELLITE ALTITUDES (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)**
Dessler, A. J., Hanson, W. B., Hertzberg, M., McKibbin, D. D., and Wrigley, R. C.
Lockheed Aircraft Corp., Missiles and Space Division,
Sunnyvale, Calif.
American Astronautical Society, Palo Alto, Calif.
58-24

A simple rugged instrument is described which can measure at satellite altitudes; atmospheric density, atmospheric temperature, and satellite, or ballistic missile angle of pitch and yaw. When placed in a satellite, the present instrument is sensitive enough to operate up to altitudes of at least 300 mi. It is not affected by vehicle outgassing and will measure only the properties of the ambient atmosphere.

1,616 **A SIMULATOR FOR THE GRAVITATIONAL FIELD (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)**
Gaskell, R. E.
Boeing Airplane Co., Seattle, Washington
American Astronautical Society, Palo Alto, Calif.
58-25

The design of vacuum tubes and electron microscopes has been materially assisted by a "rubber sheet model" enabling simulation of two-dimensional flow of electrons in a field with logarithmic potential. A corresponding model for movement of bodies in a gravitational field is described and analyzed.

1,617 PROBLEMS OF GROUND SIMULATION OF LONG RANGE SPACE FLIGHT ENVIRONMENTAL CONDITIONS (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)
Helvey, T. C.
Radiation, Inc., Melbourne, Fla.
American Astronautical Society, Palo Alto, Calif.
58-26

Expected parameters in deep space are reviewed for which equipment and crew compartment must be designed with extremely high degree of reliability. The need for extensive static and dynamic engineering testing is emphasized by the weight penalty for any excessive safety factor. Various testing techniques are described with special emphasis on multiple stresses, including cosmic ray, meteoric environment, etc. Problems are listed concerning testing the efficiency and reliability of the crew capsule. Finally, the need for a special selection, training and indoctrination base for space crew is discussed.

1,618 AROUND THE MOON IN 80 HOURS (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)
Cole, D. M., and Muir, D. E.
Martin Co., Denver, Colo.
American Astronautical Society, Palo Alto, Calif.
58-27

A conceptual design of a manned circumlunar vehicle for the early 1960's is presented showing how early availability and low cost can be achieved by making maximum use of ICBM hardware and facilities. Results of orbit, space medicine, and re-entry studies critical to the circumlunar flight are included. A trip time of approximately 80 hr appears to be a reasonable compromise between human and vehicle requirements.

1,619 SOLAR AND LUNAR PERTURBATIONS OF A SATELLITE ORBIT (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)
Gradecak, V.
Ryan Aeronautical Co., San Diego, Calif.
American Astronautical Society, Palo Alto, Calif.
58-28

By selecting an Earth's satellite orbit suitable as a home base for lunar operations, its characteristic elements are specified in such a manner that the satellite's orbital plane is co-planar with the Moon orbit. With this requirement the perturbations of the satellite orbit are obtained which can assume large values for many revolutions of the satellite. The influence of the Sun and the Moon only is considered and its magnitude is calculated by means of a usual perturbation theory. The result of the investigation shows that the Moon exerts a very much more pronounced disturbance on the satellite orbit than the Sun. The influence of the Moon is periodic in cycles of about eight years, whereas, the influence of the Sun is of the nature of secular perturbations, the magnitude of which is small but accumulative with time.

1,620 **MINIMUM WEIGHT AND OPTIMUM FLIGHTPATH OF LOW-ACCELERATION SPACE VEHICLES (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)**
Michielsen, H. F.
Lockheed Aircraft Corp., Missiles and Space Division, Sunnyvale, Calif.
American Astronautical Society, Palo Alto, Calif.
58-29

Mass ratios of a low-thrust high-energy space vehicle are optimized under the assumption that a fixed relation exists between the power and the weight of an energy generating and converting device. It is shown that the performance, in terms of total impulse, can be improved by allowing for more time under power. In an application to a round trip between satellite orbits around the Earth and Mars, it is indicated that optimum operation seems to require considerable coasting periods between escape and capture maneuvers in the planets' gravitational fields. In addition, this coasting must not follow the Hohmann ellipse for best economy. It is found that with a payload mass ratio of 4.3, actual travel time would require around 335 days to Mars and 298 days back from Mars, with an exploration time in the Mars orbit of 465 days in between. This is based on the most conservative information on power-weight ratios presented in recent publications.

1,621 **PRACTICAL CONSIDERATIONS FOR ASTRONAUTICAL GUIDANCE AND CONTROL (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)**
Gow, K. P., and Roberson, R. E.
North American Aviation, Inc., Downey, Calif.
American Astronautical Society, Palo Alto, Calif.
58-30

This paper discusses a number of the factors to be considered when selecting a mechanization for guidance and attitude control of a space vehicle. The major environmental factors are summarized as they influence the mechanization, as are the implications of the propulsion method and the auxiliary power plant. The philosophy is proposed of mechanizing primarily on the basis of reliability of those elements which must function for months or years, rather than merely adding functional extensions to the main boost guidance system. Significant unknowns and problem areas which must be faced are briefly discussed with the hope of spurring further action in these areas.

1,622 **COMPARISON OF TWO-DIMENSIONAL AND THREE-DIMENSIONAL ANALYSES OF EARTH-MOON FLIGHT WITH AND WITHOUT MID-COURSE GUIDANCE (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)**
Gunkel, R. J., and Goldbaum, G. C.
Douglas Aircraft Co., Inc., Santa Monica, Calif.
American Astronautical Society, Palo Alto, Calif.
58-31

Studies have been conducted to determine the accuracy requirements on the variables which affect the probability of lunar impact. This paper summarizes the results of analyses based on (1) a simplified two-dimensional geocentric system, including the Earth, Moon, and missile, (2) a three-dimensional system, including the Earth, Moon, and missile, (3) a three-dimensional system, including all of the planets, the Sun, Moon, and missile. In addition, a comparison was made of the probability of lunar impact on a specific area of the Moon by retro-firing in the vicinity of the Moon. The results of this paper were obtained by IBM 704 machine calculations from programs which include the relative gravitational effects of all major bodies of the solar system, the ellipticity of their orbits, and their relative motion in space in accordance with the present ephemerides.

1,623 **THE EFFECT OF AERODYNAMIC FORCES ON SATELLITE ATTITUDE (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)**
DeBra, D. B.
Lockheed Aircraft Corp., Missiles and Space Division, Sunnyvale, Calif.
American Astronautical Society, Palo Alto, Calif.
58-32

The effects of torques due to aerodynamic drag and the gravity gradient are computed for satellites orbiting between 80 and 375 mi altitude. Motion about the pitch axis is also discussed. The equilibrium position is determined as a function of altitude for both a dumbbell and a cylindrically-shaped object. The equilibrium position of the cylindrical object in three dimensions is discussed as a function of altitude. Equations are presented in an appendix.

1,624 **ON THE PROBLEMS OF RE-ENTRY OF A MANNED VEHICLE FROM SATELLITE OR LUNAR ORBITS (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)**
Robinson, A. C., Schwebs, D. H., and Besonis, A. J.
Wright Air Development Center, Wright-Patterson AFB, Ohio Aeronautical Research Lab.
American Astronautical Society, Palo Alto, Calif.
58-33

The magnitude of the problem is defined by the kinetic and potential energy content of orbiting vehicles. Possible solutions are discussed. Deceleration, total heat input, heat-rate and recovery accuracy are selected as criteria for successful re-entry and boundaries are established as a result of human tolerances and technological limitations. The results of large numbers of computer-runs are presented for zero-lift, low lift-to-drag ratio and variable drag configurations, and their relative merits and limitations are discussed in view of the established criteria.

This study has been conducted for re-entry speeds ranging from those consistent with re-entry from a near satellite orbit to those consistent with a circumlunar vehicle. It is shown that deceleration and peak heating rates present no major difficulty, being not larger than those occurring in ballistic missile re-entries. The total heat input, however, is much larger than for ballistic missiles, as the heating occupies a much longer time. It appears that a simple ballistic re-entry will be feasible from satellite orbits. The lunar re-entry, however, presents a severe total-heat problem, and the accuracy requirements are such that some lift or other control will probably be required.

1,625 **ELLIPTICAL ORBIT LIFETIMES (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)**
Breakwell, J. V., and Koehler, L. F.
Lockheed Aircraft Corp., Missiles and Space Division, Sunnyvale, Calif.
American Astronautical Society, Palo Alto, Calif.
58-34

Present atmospheric density models are investigated as they relate to the observed lifetime of *Sputnik I*. A density-altitude curve consistent with the latest atmospheric density measurements obtained from recent satellite observations is developed. Drag-life curves are also presented to permit the estimation of orbit lifetimes for perigee altitudes from 90–370 nautical mi and for elliptical orbits having an eccentricity range from 0–0.20. The drag-life time of a given satellite is then computed, based on a denser atmosphere consistent with *Sputnik I* lifetime.

1,626 **THE EFFECT OF DRAG ON ELLIPTIC ORBITS (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)**
Williams, H. E.
Jet Propulsion Laboratory, California Institute of Technology, Pasadena
American Astronautical Society, Palo Alto, Calif.
58-35

The effect of atmospheric drag on a satellite in the uniform central field of a non-rotating Earth is investigated by developing each of the dependent variables in terms of a small parameter (the ratio of the drag force at perigee to the "centrifugal" force at perigee). The resulting perturbation functions are expressible in terms of the basic elliptic orbit properties and a general atmospheric density model. For the case of small eccentricity, these results are amenable approximations of simple form.

1,627 **VARIATION OF PARAMETERS AS APPLIED TO RE-ENTRY TRAJECTORIES (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)**
Baker, R. M. L., Jr.
Aeronutronic Systems, Inc., Glendale
American Astronautical Society, Palo Alto, Calif.
58-36

A variation-of-parameters perturbational technique is presented which has been developed for the analysis of re-entry trajectories. The new technique has the advantages of both higher accuracy and greater computational speed over the commonly employed re-entry calculations that involve integrations of all forces (known to astronomers as Cowell's method). Applications to both re-entry from satellite and interplanetary orbits which will include lift, as well as drag, are discussed.

1,628 **THE TWO-DIMENSIONAL LIBRATIONS OF A DUMBBELL-SHAPED SATELLITE IN A UNIFORM GRAVITATIONAL FIELD (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)**
Stocker, T. A. J., and Vachino, R. F.
Wright Air Development Center, Wright-Patterson AFB, Ohio
American Astronautical Society, Palo Alto, Calif.
58-37

Many proposed applications of artificial Earth satellites require that the satellites be oriented relative to the direction of the Earth, the local vertical. It has been proposed that a satellite in the shape of a dumbbell inherently senses the direction of the vertical. The motion of such a dumbbell has been studied by first deriving the equation of motion of a point-mass satellite in a central force field—the classical two-body system—and then by extending the analysis to the modified three-body system which the dumbbell presents. The three equations of motion of the dumbbell are derived using Newton's law and are then simplified by a series of approximations in order to compare the attitude and orbital motion of the dumbbell with the motion of a point-mass satellite. The complete equations of motion of the dumbbell are programmed on a digital computer for various initial orbital and dumbbell attitude conditions and for different dumbbell lengths. The results show that only in a circular orbit can the dumbbell ever be permanently aligned along the local vertical, and that for elliptical orbits of small eccentricity the dumbbell performs undamped sinusoidal oscillations of varying amplitude and frequency. In elliptical orbits of high eccentricity the dumbbell rotates almost continuously. The dumbbell length and its attitude motion do not perturb its orbit.

1,629 **IMPACT PROTECTION FOR THE HUMAN STRUCTURE (Presented at the Western Regional Meeting, Stanford University, Palo Alto, Calif., August 18–19, 1958)**
Kornhauser, M.
General Electric Co., Philadelphia, Pa., Aerosciences Lab.
American Astronautical Society, Palo Alto, Calif.
58-38

The tolerance of humans to transient accelerations is presented in a form which permits rapid estimation of allowable impact velocities. As an example of the application of the human "shock-sensitivity curve," detailed analysis is made of a high-drag manned capsule on impact with water or concrete. Although it is found that no special protection is required for low speed impact, shock mounting space requirements become significant at higher impact velocities.

1,630 THE ARGUS EXPERIMENT (Presented at the Symposium on Scientific Effects of Artificially Introduced Radiations at High Altitudes, Washington, D. C., April 29, 1959)
Christofilos, N. C.
California, University of, Lawrence Radiation Lab., Livermore
American Geophysical Union, Washington, D.C.

A geophysical experiment on global scale was conducted last fall. Three small A-bombs were detonated beyond the atmosphere at a location in the south Atlantic. The purpose of the experiment was to study the trapping of the relativistic electrons (produced by the β-decay fission fragments) in the geomagnetic field. The released electrons are trapped by this field oscillating along the magnetic lines between two mirror points. In addition to this motion the electrons drift eastward, creating a thin electron shell around the Earth. The lifetime and location of the thus-created global-electron shell were measured by satellite-borne and rocket-borne instruments. Auroral luminescence was observed at the conjugate points. The electron shell exhibited remarkable stability during its lifetime. No motion of the shell or change in its thickness was detected.

This experiment was proposed a few weeks after the launching of the first *Sputnik*. After intensive investigations by several scientists, it was decided by the end of April 1958 to go ahead with the experiment. All the necessary preparations were accomplished in the amazingly short time of 4 months.

The usefulness of such electron shells for interpreting geophysical phenomena and possible future experiments are discussed.

1,631 SATELLITE OBSERVATIONS OF ELECTRONS ARTIFICIALLY INJECTED INTO THE GEOMAGNETIC FIELD (Presented at the Symposium on Scientific Effects of Artificially Introduced Radiations at High Altitudes, Washington, D. C., April 29, 1959)
Van Allen, L., Jr., McIlwain, C. E., and Ludwig, G. H.
Iowa, State University of, Iowa City
American Geophysical Union, Washington, D. C.

Our four radiation detectors in satellite 1958ε (*Explorer IV*) easily and promptly observed the geomagnetically trapped electrons resulting from the three high-altitude nuclear detonations Argus I, II, and III in August–September 1958. An account of over 160 satellite passes through the three Argus "shells" of artificially injected electrons is given herein, and a preliminary appraisal of the geophysical significance of these experiments is offered.

1,632 **PROJECT JASON MEASUREMENT OF TRAPPED ELECTRONS FROM A NUCLEAR DEVICE BY SOUNDING ROCKETS (Presented at the Symposium on Scientific Effects of Artificially Introduced Radiation at High Altitudes, Washington, D. C., April 29, 1959)**

Allen, L., Jr., Beavers, J., II, Whitaker, W., Welch, J., Jr., and Walton, R.
Air Force Special Weapons Center, Kirtland AFB, New Mexico
American Geophysical Union, Washington, D. C.

Solid-propellant rockets were sent to altitudes of 800 km from three stations in the eastern United States to observe electrons injected into the geomagnetic field from a small high-altitude nuclear detonation. The electron flux was measured by an assembly of Geiger counters. Shortly after a nuclear detonation above the south Atlantic, a narrow region of high-counting rate was observed.The geometry of the observations is related to the geomagnetic field. The region consisted of an intense band about 20 km wide (half-width at half maximum counting rate) and less intense wings extending at least 700 km north and perhaps 700 km south of the band. Neither position nor width of the band changed during the observations, which consisted of periodic soundings until 100 hr after the nuclear detonation. The intensity of both the wings and the band decayed during the measurements as $1/t$, which is consistent with the hypothesis that small-angle scattering is the dominant loss mechanism. The angular distribution of the radiation was measured, and the electron flux was observed to be confined very nearly to the plane perpendicular to the field lines. Spectral measurements show far fewer electrons above 4 Mev than were expected from the fission beta spectrum. Betas trapped from the decay of neutrons emitted from large-yield, high-altitude weapon tests in the Pacific were also noted.

1,633 **THEORY OF GEOMAGNETICALLY TRAPPED ELECTRONS FROM AN ARTIFICIAL SOURCE (Presented at the Symposium on Scientific Effects of Artificially Introduced Radiations at High Altitudes, Washington, D. C., April 29, 1959)**

Welch, J., Jr., and Whitaker, W. A.
Air Force Special Weapons Center, Kirtland AFB, New Mexico
American Geophysical Union, Washington, D. C.

A theoretical formulation has been made for the history of an artificial shell of geomagnetically-trapped electrons resulting from low-yielding nuclear detonations in the exosphere. The formulation assumes a source distribution and gives the spatial distribution of trapped electrons along the magnetic field lines, the drift rate around the world, and the configuration of the resulting shell. Interactions of the shell with the atmosphere lead to an electron density decaying inversely with time from injection for times longer than a characteristic lifetime that is a function of altitude and electron energy. The electron flux is found to be very nearly confined to a plane perpendicular to the field direction after several characteristic lifetimes. Scattering by geomagnetic fluctuations is probably not an important loss mechanism for the artificial shell, but it may be important

for the hard component of the natural trapped belt. The effect of the geomagnetic anomaly over the south Atlantic has been described qualitatively. Jason rocket data and *Explorer IV* satellite data have been compared with the theoretical results.

1,634 OPTICAL, ELECTROMAGNETIC, AND SATELLITE OBSERVATIONS OF HIGH-ALTITUDE NUCLEAR DETONATIONS, PART I (Presented at the Symposium on Scientific Effects of Artificially Introduced Radiations at High Altitudes, Washington, D. C., April 29, 1959)

Newman, P.
Air Force Cambridge Research Center, Bedford, Mass., Propagation Sciences Lab.
American Geophysical Union, Washington, D. C.

After each of the high-altitude detonations in the Argus experiment, visual auroras were observed in the detonation area. After the third event an aurora was observed in the conjugate area. After the second and third events, signals attributed to hydromagnetic waves were detected in the conjugate region; these signals had a periodicity of about 1 cycle/sec. The maximum change in the magnetic field was about 1 gamma. If propagated along the magnetic line of force the velocity was about 2000 km/sec. Sporadic E was observed after the third event in the conjugate area. Comparative records of the 5577 Å and 3914 Å lines were obtained in the detonation area.

1,635 OPTICAL, ELECTROMAGNETIC, AND SATELLITE OBSERVATIONS OF HIGH-ALTITUDE NUCLEAR DETONATIONS, PART II (Presented at the Symposium on Scientific Effects of Artificially Introduced Radiations at High Altitudes, Washington, D. C., April 29, 1959)

Peterson, A. M.
Stanford Research Institute, Menlo Park, Calif.
American Geophysical Union, Washington, D. C.

The radio effects of the Argus detonations were measured using (1) 30-mc radars designed to obtain echoes from the aurora or from the Earth's surface mirrored in an enhanced ionospheric layer, (2) VLF receivers for monitoring distant transmitters or atmospheric noise sources in search of changes in signal strength, (3) riometers for recording cosmic noise absorption or VHF shot-created noise at 30, 60, and 120 mc.

Results included (1) auroral echoes in the vicinity of the launch point after all three shots and near the conjugate points after the first and third shot, (2) sudden depressions of 6 to 12 db of the signal from England (19.6 kc) at Madrid and the Azores, (3) no ionospheric absorption at the conjugate location.

1,636 **A RECOVERABLE INTERPLANETARY SPACE PROBE: Volumes I–IV**
July 1959
Massachusetts Institute of Technology, Cambridge, Instrumentation Laboratory
R 235

A recoverable interplanetary space probe has been comprehensively investigated and its feasibiltiy has been established. There is presented a preliminary design of a vehicle whose mission is to return safely to Earth with a useful payload which could be a high-resolution photograph of a neighboring planet. Navigational techniques and interplanetary orbits have been studied in detail to determine basic performance and accuracy attainable for a variety of interplanetary missions. These numerical results, assuming reasonable navigational instrument errors, indicate that only moderate propulsion requirements for orbital velocity corrections are necessary. The vehicle weight in the preliminary design is well within the capability of soon-to-be-available rocket vehicles for initial boost into a planetary transfer orbit. The vehicle presented contains an automatic navigation and attitude control system using a digital computer and electromechanical-optical accessories, a microrocket system for making navigational corrections, a long range communication system for transmitting useful intelligence, and a re-entry vehicle with associated radio and light beacon aids for the physical recovery of the payload. The over-all vehicle weight is approximately 340 lb.

The four volumes contain the following chapters and appendices: Introduction; A Description of the Recoverable Interplanetary Space Probe Experiment; A Plan for an Experimental Program; Fundamentals of Round Trip Interplanetary Trajectories; Theory of Space Ship Navigation; Functional Configuration and Operation of Space Vehicle; Structural–Thermal Configuration; Electrical System; Description of the Accessories; Computer; Micro Rocket; Communication System; Re-entry Vehicle Design; Photographic Prospect; Radiation Environment; The Determination of Round-Trip Planetary Reconnaissance Trajectories; General Theory of the Navigational Fix; The Fundamental Perturbation Matrices; Formulation of a Navigation Theory; Midcourse Navigation Error Analysis; Error Analysis for Planetary Approach; Procedure for Computation for the Fundamental Matrices; Space Vehicle Computer Programming; Disk Scanning.

1,637 **THE HEAT PROTECTION POTENTIAL OF SEVERAL ABLATION MATERIALS FOR SATELLITE AND BALLISTIC RE-ENTRY INTO THE EARTH'S ATMOSPHERE**
Diaconis, N. S., Fanucci, J. B., and Sutton, G. W.
September 11, 1959
General Electric Co., Philadelphia, Pa., Aerosciences Lab.
R 59SD423

An evaluation of the relative performance advantage of various ablation materials for the heat protection to a non-lifting vehicle during hypersonic re-entry into the Earth's atmosphere has been made based on theoretical ablation models substantiated by experiment. Calculations have also been made of the heat penetration within the material. Typical ablation materials from three categories have been investigated, both theoretically and experimentally, in air arc facilities at a hypersonic stagnation point.

Stagnation point ablation data for an attractive material in each category was obtained for various local heating rates, stagnation pressures and stagnation enthalpies. Effective heats of ablation have been determined experimentally and compared with the theoretical calculations.

1,638 **LUNAR TRAJECTORY STUDIES**
Lieske, H. A.
February 26, 1958
RAND Corp., Santa Monica, Calif.
P-1293

A simplified model of the Earth-Moon system is used to investigate the variation of initial trajectory parameters required to hit the Moon. Typical transit trajectories for various missions near the Moon are discussed, and estimates of initial errors are given. Trajectories which pass near the Moon and return to, or near, the Earth are also developed and several examples are shown.

1,639 **PROCEEDINGS OF LUNAR AND PLANETARY EXPLORATION COLLOQUIUM**
March 18, 1959
North American Aviation, Inc., Los Angeles, Calif.
Vol. 1, No. 5

The following list includes titles of the papers presented and their authors: "The Escape of Planetary Atmospheres," H. C. Urey; "Comparison of Lunar and Terrestrial Surface Features," J. Green; "Mars or Venus?" W. H. Straley; "Results of *Pioneer IV* Flight," A. R. Hibbs; "The Venusian Atmosphere," S. H. Dole; "X-Ray Techniques for Probing the Lunar Surface," E. D. Goldberg; and "Measuring the Venusian Atmosphere by Russel's Method," J. B. Edson.

1,640 **DESIGN AND EVALUATION OF SPACE COMMUNICATIONS SYSTEMS USING COMPUTER SIMULATION TECHNIQUES (Presented at 1959 National Symposium on Space Electronics and Telemetry, September 28, 30, 1959, San Francisco)**
White, D. R. J.
American Machine and Foundry Co., Alexandria Division, Alexandria, Va.
Proceedings of the Institute of Radio Engineers,
Institute of Radio Engineers, Inc., New York
Paper 1.1

This paper describes a high-speed, digital computer simulation approach to the design and evaluation of space communications systems. Emphasis is placed on the development and use of system variables for predicting performance of either existing or proposed system designs.

Several mathematical models of transmitter and receiver characteristics, propagation phenomena, signal acceptability criteria, and scoring techniques are given in graphic and tabular form. They are combined with cost or state-of-art and reliability weighing factors to evaluate performance in light of certain objectives or users' needs. Although approximately 100 variables and many theoretical and empirical relations are programmed on an IBM-704 computer, different trial designs can be readily scored on an absolute basis and quantitatively compared as these variables are manipulated to obtain a good over-all system design.

1,641 THE USE OF PCM IN DATA LINKS WITH SATELLITES, SPACE VEHICLES AND LONG-RANGE MISSILES (Presented at the 1959 National Symposium on Space Electronics and Telemetry, September 28–30, 1959, San Francisco)
Sink, R. L.
Consolidated Electrodynamics Corp., Pasadena, Calif.
Proceedings of the Institute of Radio Engineers,
Institute of Radio Engineers, Inc., New York
Paper 1.2

This report is devoted to examining the feasibility and limitations of digital methods for the storage, transmission and recovery of data in vehicles operating under marginal or limiting transmission conditions. The emphasis is placed upon establishing the probable limits of capabilities of digital methods as data transmission and storage links, as determined by probable system capabilities within the next five years. Definitions of the problems are given and compared with the data-link requirements in terms of speed, bandwidth, storage, resolution, etc. The types of data considered for transmission and storage will include visual, engineering, and space information.

1,642 PHASE-LOCK IN SPACE COMMUNICATIONS (Presented at the 1959 National Symposium on Space Electronics and Telemetry, September 28–30, 1959, San Francisco)
Sampson, W. F., and Ruegg, F. A.
Hallamore Electronics Co., Anaheim, Calif.
Proceedings of the Institute of Radio Engineers,
Institute of Radio Engineers, Inc., New York
Paper 1.3

A circuit with automatic phase control, commonly called a phase-locked loop, which approaches synchronous detection while performing locked (in frequency) tracking of radio signals from missiles, probes, or satellites over a predetermined doppler range is described. The hardware involved in the phase-locked loop is practical and easily stabilized.

1,643 A COMMUNICATION SYSTEM FOR A SMALL INTERPLANETARY VEHICLE (Presented at the 1959 National Symposium on Space Electronics and Telemetry, September 28–30, 1959, San Francisco)
Skolnik, M. I. and Cartledge, L.
Massachusetts Institute of Technology, Lincoln Lab., Lexington
Proceedings of the Institute of Radio Engineers,
Institute of Radio Engineers, Inc., New York
Paper 1.4

Results are described of a feasibility study of communicating with a small interplanetary space probe whose primary mission is to photograph the surface of Mars and return to Earth to be recovered. The proposed probe, being primarily a photographic one, has small requirements and power available for communication. Operating frequency, modulation waveform, and transmitter design are considered. Brief mention is made of ground antennas and the problem of two-way communication with the vehicle.

1,644 DATA RECOVERY—NEW APPROACHES REQUIRED FOR RE-ENTRY VEHICLE INSTRUMENTATION (Presented at the 1959 National Symposium on Space Electronics and Telemetry, September 28–30, 1959, San Francisco)
Lathrop, P. A.
General Electric Co., Philadelphia, Pa.
Proceedings of the Institute of Radio Engineers,
Institute of Radio Engineers, Inc., New York
Paper 3.1

The need for a completely new type of hardware for vehicles leaving and re-entering the Earth's atmosphere has caused the development of instrumentation systems designed to recover data from flight regardless of the degree of success of the basic vehicle design in withstanding the rigors of re-entry. These new systems contained every permissible type of redundacy, within payload limitations, to ensure retrieval of sufficient flight data to provide design inputs for later flight hardware. This paper describes the systems requirements, design solution, the Data-Recovery Capsule, system operation and reliability for a re-entry vehicle.

1,645 ANALYSIS AND PREDICTION OF RADIO SIGNAL INTERFERENCE EFFECTS DUE TO IONIZED LAYER AROUND A RE-ENTRY VEHICLE (Presented at the 1959 National Symposium on Space Electronics and Telemetry, September 28–30, 1959, San Francisco)
Taylor, W. C.
Lockheed Aircraft Corp., Missiles and Space Division, Sunnyvale, Calif.
Proceedings of the Institute of Radio Engineers,
Institute of Radio Engineers, Inc., New York
Paper 3.2

Principally this report treats the problem of transmission of electromagnetic waves through the thermally-ionized layer of gases in the shock layer around a hypersonic missile. Giving simplified theory, methods, and graphic aids for approximate predictions of the problem, it also presents some specific results for a typical hemisphere-cylinder vehicle shape. While details of the theory allowing computation of temperature and the concentration of electrons and neutral particles are not given, a method which has been used is outlined and referenced.

It is concluded that a 200 mc signal will experience significant attenuation due to air ionization when peak re-entry velocities exceed about 11,000 or 12,000 ft/sec. Although it may not be true in every case, it is predicted that an increase in signal frequency above the 200 mc region for a midsection-radiation wave will lessen the attenuation problem of missiles with ranges up to and including "intermediate."

1,646 **DIGILOCK TELEMETRY SYSTEM (Presented at the 1959 National Symposium on Space Electronics and Telemetry, September 28–30, 1959, San Francisco)**
Sanders, R. W.
Space Electronics Corp., Glendale, Calif.
Proceedings of the Institute of Radio Engineers,
Institute of Radio Engineers, Inc., New York
Paper 6.3

A communication system particularly for use in space applications, known as the Digilock system which, by means of very simple circuitry, approaches closely the Shannon communication efficiency limit is described along with the engineering considerations involved in determining system parameters.

The Digilock system employs a version of the binary signals known as Reed-Muller codes. The airborne portion of the Digilock system is composed entirely of solid-state components.

1,647 **A HIGH CAPACITY PAM-FM-FM TELEMETERING SYSTEM FOR THE *SATURN* BOOSTER (Presented at the 1959 National Symposium on Space Electronics and Telemetry, September 28–30, 1959, San Francisco)**
King, O. B.
Army Ballistic Missile Agency, Redstone Arsenal, Ala.
Proceedings of the Institute of Radio Engineers,
Institute of Radio Engineers, Inc., New York
Paper 7.1

This paper describes a 216 channel PAM-FM-FM telemetering system developed for use with the *Saturn* missile. A brief description of the *Saturn* is given and specific problems in connection with booster telemetering are discussed. The requirements for a new telemeter system are set forth and design objectives established. The resulting telemeter is discussed with emphasis on the multiplexer portions. In conclusion, specifications and performance are outlined.

1,648 SS FM: A FREQUENCY DIVISION TELEMETRY SYSTEM WITH HIGH-DATA CAPACITY (Presented at the 1959 National Symposium on Space Electronics and Telemetry, September 28-30, 1959, San Francisco)
Frost, W. O., and King, O. B.
Army Ballistic Missile Agency, Redstone Arsenal, Ala.
Proceedings of the Institute of Radio Engineers,
Institute of Radio Engineers, Inc., New York
Paper 7.2

This paper describes the results of a theoretical study and preliminary design for a telemetry system with high-data bandwidth capability. The system basically consists of single sideband AM subcarriers on an FM carrier, making the letter designation SS-FM appropriate. An analytical comparison with FM-FM is made of the S/N performance of a 15 channel SS-FM system. This comparison indicates SS-FM has an advantage over a reference FM-FM channel of the same data capacity. This advantage depends on the frequency location of approximately unity to over 20 db. A system under development at ABMA for the *Saturn* missile is described. Component, circuit, and system problems are enumerated, and solutions presented. In conclusion, the expected physical and electrical characteristics of the system are outlined and the advantages of SS-FM summarized.

1,649 A REACTANCE MODULATED F-M TRANSMITTER FOR SPACE COMMUNICATIONS OR TELEMETRY (Presented at the 1959 National Symposium on Space Electronics and Telemetry, September 28–30, 1959, San Francisco)
Heninger, G. O. (Member, IRE), and Pasos, R. F.
Philco Corp., Western Development Labs., Palo Alto, Calif.
Proceedings of the Institute of Radio Engineers,
Institute of Radio Engineers, Inc., New York
Paper 9.3

Microwave power may be generated at the 2-kmc region with a cavity oscillator using a planar power triode in a grid-isolation circuit. Such a transmitter has been developed, using crystal diodes coupled into the cathode cavity to obtain a variable reactance for frequency modulation. The theory of operation is presented, treating in turn the following: rf generator, modulator, automatic frequency control, and power supply. This transmitter for space to Earth communications was designed with the following general requirements in mind: minimum weight, high efficiency and excellent reliability, high enough frequency to make use of small directional antennas and readily penetrate the Earth's ionized layers, but not high enough to be bothered by variable atmospheric conditions, and mechanical design rugged enough to withstand severe vibration, shock and temperature variations during ascent and use conditions.

1,650 **A NEW TELEMETRY TRANSMITTER USING A VOLTAGE-TUNED MAGNETRON FOR SPACE ENVIRONMENT (Presented at the 1959 National Symposium on Space Electronics and Telemetry, September 28–30, 1959, San Francisco)**
Jensen, C. L.
Philco Corp., Philadelphia, Pa.
Proceedings of the Institute of Radio Engineers,
Institute of Radio Engineers, Inc., New York
Paper 9.4

Based on the high efficiency performance of the voltage-tuned magnetron, this tube is a logical choice for operation in a space vehicle for a telemetry transmitter. However, since the voltage-tuned magnetron is a basically a wide-band device, adapting it to a narrow-band application involves utilizing some new techniques in high voltage regulation and AFC to maintain a stable frequency. This paper describes techniques that have been used to hold the center frequency to within $\pm 0.002\%$, utilizing a voltage-tuned magnetron with an average FM sensitivity of 1 megacycle per volt of anode voltage.

1,651 **A NAVIGATION THEORY FOR ROUND-TRIP RECONNAISSANCE MISSIONS TO VENUS AND MARS**
Battin, R. H., and Laning, J. H., Jr.
August 1959
Massachusetts Institute of Technology, Cambridge, Instrumentation Lab.
R-240

A self-contained navigation scheme is described and analyzed for the case of an unmanned spaceship launched from Earth and established in a free-fall solar orbit that passes within a few thousand miles of another planet and subsequently returns to Earth. A statistical study of the navigation errors and the micro-rocket fuel requirements is made, using a three-dimensional model of the solar system. Several different trajectories are subjected to a systematic study to determine the optimum times at which positional checks and velocity corrections should be made in order to minimize both the amount of fuel required and the errors in passing distance at the target planet and miss distance upon return to Earth.

1,652 **THE DRAG BRAKE MANNED SATELLITE SYSTEM (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, August 30—September 5, 1959)**
Detra, R. W., Kantrowitz, A. R., Riddell, F. R., and Rose, P. H.
Avco Manufacturing Corp., Everett, Mass.
Avco-Everett Research Lab.
Research Report No. 64

The manned satellite designs which have been discussed publicly are all either adaptations of airplane or missile nosecone technology. This paper presents another viewpoint on the design of such a vehicle. Instead of extrapolating one of the above devices, a fresh approach to the design of a manned satellite system was made. The result of this three-year effort has been a manned satellite design based on a drag brake, and intended to achieve early realization of manned spaceflight.

The re-entry heating problem and the deceleration which must be faced by a human passenger during re-entry have dominated most manned satellite discussions. However, progress made during the ICBM program has enabled the design of a vehicle without over-emphasis on the re-entry heating considerations and the progress which has been made in aero-medical research makes it clear that the 8 *g* decelerations which must be faced in the constant-drag re-entry are not a serious problem. Thus it appears evident that the re-entry problem should not design the vehicle.

There are a number of other problems which must be faced in the design of manned satellites. First, the high strength required of structures which protrude from the launch vehicle envelope involves a greater weight penalty. On the other hand, large surface areas are required to produce drag or other aerodynamic forces in orbit due to the tenuous upper atmosphere. These requirements dictate folding structures. A mechanism for effecting a satisfactory landing must also be included in a design. Finally, it is clear that a reduction in the number of components needed to accomplish the several functions will always be an advantage from the overwhelming important standpoint of reliability.

The manned satellite design proposed in this paper is built around a foldable, light, stainless steel, umbella-like brake. Opening and closing the structure in orbit results in a 20:1 drag variation. This drag variation causes a corresponding change in the rate of descent or orbital lifetime. Controlled variation of the drag according to a present program permits landing at a pre-selected point with an accuracy of 150 nm. The extended structure has a low loading, only 1.5 lb/sq ft, and consequently the vehicle decelerates high in the atmosphere, radiating the heat away at temperatures which never exceed present turbine practice. The drag brake also yields sufficiently slow terminal velocity so that no additional parachutes are required. Thus, a single new component, the drag brake, is proposed which performs a multiplicity of functions which are performed by individual systems in other designs. In addition to the obvious reliability advantage, the multiple use of this simple component also results in very substantial weight savings.

For a given capsule and payload, the elements associated with altitude stabilization, recovery from orbit, re-entry, landing accuracy control and final landing of the system described comprise less than half the weight required for the same functions in presently envisioned retro-rocket systems.

1,653 THE CENTRAL PROBLEM OF LARGE SCALE POWER GENERATION IN SPACE-WASTE HEAT DISPOSAL (Presented at the IAS National Summer Meeting, Los Angeles, California, June 16–19, 1959)
Diamond, P. M.
CONVAIR, San Diego, Calif.
Institute of the Aeronautical Sciences, Inc., New York
IAS Paper 59-96

This paper discusses certain aspects of the characteristics of large power plants for operation in a space environment with special emphasis on the problem of the weight of the unit. System requirements are discussed as influenced by the mission requirements of the space vehicle employing the power plant and by the environmental factors, such as meteoroid penetration, which will influence its operation.

1,654 **RADIATION PRESSURE CONFINEMENT, THE SHOCK PINCH AND FEASIBILITY OF FUSION PROPULSION**
Clauser, M. U. and Weibel, E. S.
1959
Space Technology Laboratories, Inc., Los Angeles, Calif.
Physical Research Lab.

This report describes the research work on two approaches to the control of the fusion reaction. The containment of a plasma in a cavity by means of a radiation field is analyzed. A description is given of the work on nonadiabatic or shock heating, and the feasibility of thermonuclear rocket propulsion is examined.

1,655 **A MAGNETOHYDRODYNAMIC MODEL FOR A TWO-DIMENSIONAL MAGNETIC PISTON**
Meyer, R. X.
March 4, 1959
Space Technology Laboratories, Inc.
Los Angeles, Calif., Physical Research Lab.
TR-59-0000-00617

The possibility of imparting a very high velocity to an ionized gas by means of a traveling magnetic field in a linear geometry has been recognized for some time. A typical configuration for applying this principle to plasma propulsion and to electromagnetic shock tubes is indicated in this report. In this configuration, a magnetic field moving in one direction accelerates a gas in the same direction. A shock wave propagates into the cold gas, which is heated to a temperature sufficient for ionization. The effect of the magnetic field on the gas may be compared qualitatively with the effect of a mechanical piston. The geometry of the field is similar to the one encountered in mirror machines. The mean free path is much smaller than the dimensions of the apparatus, and the Larmor frequency of the electrons in the magnetic field is usually lower than the collision frequency, indicating that a hydrodynamic treatment with a scalar conductivity is called for.

The plasma diffuses through the field because of the finite conductivity of the gas. The principal aim of this report is to compute the mass flow rate of gas leaking through the magnetic piston, in the regime of continuum flow. The analysis is confined to a plane geometry, rather than to a rotationally symmetric one.

1,656 OPTIMUM POWER GENERATION USING A PLASMA AS THE WORKING FLUID (Presented at the ARS-Northwestern Gas Dynamics Symposium, Northwestern University, Evanston, Illinois, August 24–26, 1959)
Neuringer, J. L.
Republic Aviation Corp., Farmingdale, N. Y.
Plasma Propulsion Lab.
American Rocket Society, New York
Paper 907-59

With the possibility of controlled thermonuclear fusion in the future, the question arises whether it would be possible to use the plasma itself as the working fluid to generate electric power by electromagnetic induction. The problem considered here is the steady one-dimensional motion of a plasma in a channel of arbitrary and slowly varying cross-section. The plasma flows across a transverse magnetic field of arbitrarily varying strength, and the conducting channel walls are connected to an external resistive load of arbitrary magnitude. The question is asked, "For a channel of given entrance cross section and length, what must be the shape of the channel, distribution of magnetic field strength and external loading so that maximum power may be extracted by the external load?" The extremum problem is formulated using the techniques of the calculus of variations to obtain the appropriate system of differential constraints, i.e. the fluid flow equations, are integrable, analytical solutions are obtained exhibiting the dependence of the required loading on the Magnetic Reynolds' number and the flow Mach numbers based on the sonic and Alfvén wave speeds. The power, electrical-conversion efficiency, terminal voltage, and distribution of the fluid mechanical variables along the channel are also presented as functions of the above dimensionless parameters.

1,657 SPACE PROPULSION ENGINES—A PROBLEM IN PRODUCTION OF HIGH VELOCITY GASES (Presented at the ARS-Northwestern Gas Dynamics Symposium, Northwestern University, Evanston, Illinois, August 24–26, 1959)
Ghai, M. L.
General Electric Co., Evendale, Ohio
American Rocket Society, New York
Paper 908-59

A basic problem of space propulsion engines is to generate gases at very high velocities—about 8 to 100 times the gas velocities generated by the conventional jet engines. Three electric propulsion engines inherently capable of producing the required velocities are presented: (1) the ElectroThermal propulsion or the Arc-Jet engine, (2) the Plasma propulsion or the Magnetohydrodynamic engine, and (3) the Ion-Propulsion engine.

Ability to generate high velocity gases enables these engines to make large savings in propellant consumption and deliver increased payloads, as compared to chemical rockets. They also provide precise thrust regulation because of the inherent controllability of electrical power. The ElectroThermal engine has

inherent ability to operate efficiently at specific impulses below about 1,500 to 2,000 sec, the Plasma engine above about 1,500 sec, and the Ion engine above about 6,000 sec specific impulse. Thus, the three engines complement each other very well.

ElectroThermal propulsion involves generation and handling of partially ionized gases at very high temperatures. Some experimental results are presented to indicate the extent of the problems such as ablation, container efficiency, heat transfer and arc stability. Some mission capabilities for the ElectroThermal engine are presented.

Plasma propulsion involves generation and acceleration of highly ionized gases under the influence of magnetohydrodynamic forces.

1,658 **THE ELECTROMAGNETIC PINCH EFFECT FOR SPACE PROPULSION (Presented at the ARS-Northwestern Gas Dynamics Symposium, Northwestern University, Evanston, Illinois, August 24–26, 1959)**
Kunen, A. E., and McIlroy, W.
Republic Aviation Corp., Farmingdale, N. Y.
American Rocket Society, New York
Paper 908-59

The phenomenon of the electromagnetic pinch effect is used to accelerate ionized gases for space propulsion. Electrical energy, initially stored in capacitors, is discharged across two nozzle-shaped electrodes wherein the radial pinch is converted to axial motion of the effected gases instead of confinement at the axis.

The gas dynamics of a pinch using the hydrodynamical model of a "magnetic piston" driving a shock wave, is combined with the electrodynamics of the circuit to calculate the behavior of the discharge.

Experiments on three different electrode designs are discussed and the results obtained are compared with the calculated values.

The results of the study are applied to one particular space propulsion system consisting of a nuclear energy source, a space radiator, a turbine-generator, capacitor, and a pinch tube. The specific mission analyzed is a one-way unmanned flight to Mars orbit, starting from an Earth orbit.

1,659 **NATIONAL AERONAUTICS AND SPACE ADMINISTRATION PLASMA ACCELERATION BY GUIDED MICROWAVES (Presented at the ARS-Northwestern Gas Dynamics Symposium, Northwestern University, Evanston, Illinois, August 24–26, 1959)**
Hess, R. V., and Thom, K. (NASA)
American Rocket Society, New York
Paper 909-59

A scheme of plasma acceleration is explored which makes use of the radiation pressure of guided microwaves to apply forces for plasma acceleration. The success of such a scheme depends on the recent development of microwave generators of extreme power outputs which, in the near future, should reach 100 megawatts. The radiation pressures thus obtained are further increased by storing the radiation by resonance in a finite volume, which is bounded on one side by a plasma. The scheme may show certain advantages over other methods when the accelerated plasmas are of comparatively small mass and are accelerated to extreme velocities. Possible applications of such plasmas for studies of certain aspects of thermonuclear fusion, propulsion, and communications are discussed.

1,660 APPLIED MAGNETOHYDRODYNAMICS AT AVCO-EVERETT RESEARCH LABORATORY (Presented at the ARS-Northwestern Gas Dynamics Symposium, Northwestern University, Evanston, Illinois, August 24–26, 1959)
Camac, M., and Janes, G. S.
Avco Manufacturing Corp., Avco-Everett Research Lab., Everett, Mass.
American Rocket Society, New York
Paper 902-59

This paper reports research made at Avco-Everett Research Laboratory in the field of magnetohydrodynamics—specifically in the fields of space flight propulsion, re-entry "drag" devices, low temperature process, and fusion methods.

In the section dealing with electric power generation, low temperature magnetohydrodynamic generators are discussed and power generation experiments are described.

It can be shown that increases in payload can be achieved by using electrical propulsion instead of chemical propulsion for many satellite missions. The optimum specific impulse range for electrical propulsion is from about 1,500 sec to 5,000 sec for operation within the gravitational field of the Earth and to the Moon. Electrical propulsion with neutral plasma devices can operate efficiently in this range as well as at higher specific impulses. Experimental information is presented on two neutral plasma thrust chambers: the arc jet and the magnetohydrodynamic shock tube. Some of the important factors which limit their range of efficient operation are discussed.

High temperature gas research is also discussed.

1,661 RE-ENTRY STUDIES IN FREE FLIGHT RANGES (Presented at the 7th Anglo-American Aeronautical Conference, New York, N. Y., October 5–7, 1959)
Bull, G. V.
Canada, Defence Research Board
Institute of the Aeronautical Sciences, Inc., New York
IAS Paper 59-143

Methods of studying re-entry physics in laboratory simulation facilities are considered. Some of the methods presented here are hypersonic wind tunnels of various types, plasma jets for temperature simulation, and hypersonic firing ranges. This paper presents a description of this technique as in use at the Canadian Armament Research and Development Establishment, and includes some typical measurements.

1,662 A PHOTOGRAPHIC STUDY OF BOILING IN THE ABSENCE OF GRAVITY (Presented at the Aviation Conference of the American Society of Mechanical Engineers, Los Angeles, Calif., March 9–12, 1959)
Siegel, R., and Usiskin, C. (NASA)
American Society of Mechanical Engineers, New York
Paper 59-Av-37

A photographic study was made to determine the qualitative effect of zero gravity on the mechanism of boiling-heat transfer. The experimental equipment included a container for boiling water and a high-speed motion-picture camera. To eliminate the influence of gravity, these were mounted on a platform which was allowed to fall freely approximately 8 ft. During the free fall, photographs were taken of boiling from various surface configurations such as electrically heated horizontal and vertical ribbons. The heat flux was varied to produce conditions from moderate nucleate boiling to burnout. The results indicate that gravity plays a considerable role in the boiling process, especially in connection with the motion of vapor within the liquid.

1,663 THE MOTION OF AN ARTIFICIAL EARTH SATELLITE RELATIVE TO ITS CENTER OF MASS
Beletskii, V. V.
***Izkustvennye Sputniki Zemli*, v. 1, pp. 25–43, 1958**
June 1959
Palmer, J. W.
Great Britain, Royal Aircraft Establishment
Translation 824

The motion of an artificial Earth satellite about its center of mass under the action of aerodynamic and gravitational disturbances has been analyzed, taking into account the influence of the regression of the orbit due to the Earth's oblateness.

The satellite's motion is shown to consist of a non-disturbed motion relative to the angular-momentum vector plus a secular precessional-nutational motion of the angular-momentum vector itself.

If aerodynamic disturbances predominate, this secular motion varies about a direction, close to the perigee tangent, which changes with time. If, however, gravitational disturbances predominate, the loci of the end point of the angular-momentum vector can be of two basic types: first, paths symmetrical about the orbital plane, whose center coincides with the center of aerodynamic precession; second, paths having a center lying near the center of gravitational precession.

The moments of the gravitational forces will be definitely greater than the moments of the aerodynamic forces, above altitudes of 500 km. In the height band 200-500 km, the comparative influence of the gravitational and aerodynamic disturbances depends on the design parameters of the satellite orbit.

1,664 ***THOR-ABLE* RE-ENTRY VEHICLE RECOVERY SYSTEM**
Glancey, J. T.
July 1959
General Electric Co., Philadelphia, Pa.
PIB-23

This pamphlet provides easily understood information on this water re-entry recovery system. Several pictures of the equipment after recovery are included.

1,665 ***THOR-ABLE* AND *ATLAS* RE-ENTRY RECOVERY PROGRAMS**
August 1959
General Electric Co., Philadelphia, Pa.
PIB-20

This is a descriptive summary of the General Electric re-entry recovery vehicles; *Thor-Able* Phase I, Phase II(RVX-1) and *Atlas*(RVX-2).

1,666 **DETERMINATION OF FACTORS GOVERNING SELECTION AND APPLICATION OF MATERIALS FOR ABLATION COOLING OF HYPERVELOCITY VEHICLES**
Bonin, J. H., Price, C. F., and Taylor, D. E.
July 1959
Chicago Midway Labs., University of Chicago, Ill.
Wright Air Development Center, Wright-Patterson AFB, Ohio
WADC TR 59-87

The report includes the results of an investigation for which the prime objective was the determination of the behavior of materials exposed to thermal environments representative of re-entry conditions. The environment encountered by ballistic, glide, and skip vehicles is reviewed. Heat flow into single and composite slab materials for heat sink applications is discussed. The development and calibration of an air-stabilized arc facility of a nominal 1000-kw rating is described. In the experimental phase of the investigation, representative materials were exposed to the high-temperature plasma discharge produced in stabilized arcs. The results obtained are reported upon, along with a correlation of the observed behavior with theory.

1,667 **AUXILIARY POWER FOR SPACE PROBES**
Hamilton, R. C.
August, 1959

Jet Propulsion Laboratory, California
Institute of Technology, Pasadena
External Publication 704

The various types of power sources which are currently being considered for use as space probe auxiliary power supplies are discussed. They are: silicon photovoltaic cells thermoelectricity, solar thermionic diodes, solar fuel cells, solar thermoalternators, radioisotope thermoelectric or thermionic diodes, reactor thermoelectricity, reactor thermionic diodes, and reactor turboalternators.

1,668 INSTRUMENTING THE *EXPLORER I* SATELLITE
Richter, H. L., Jr., Pilkington, W., Eyraud, J. P., Shipley, W. S., and Randolph, L. W.
Jet Propulsion Laboratory, California Institute of Technology, Pasadena
External Publication No. 492

The objectives in equipment design for the *Explorer I* were high reliability, sufficient receiver sensitivity consistent with minimum power levels to ensure continuous tracking, development of telemetry techniques to ensure wide geographical coverage and maximum lifetime, and the application of methods to keep the information bandwidth to a minimum. Two radio transmitters were designed to achieve these objectives. This report describes these transmitters and the antenna, phase modulation, conversion, amplitude modulation, resistance-control and current-control. Testing and calibration of the satellite and the micrometeorite detectors used are also described.

1,669 IMPROVED LUNAR EPHEMERIS, 1952–1959
[A Joint Supplement to the American Ephemeris, and the (British) Nautical Almanac]
1954
Naval Observatory, Washington, D. C.

The contents of this publication include tables on the longitude, latitude, and horizontal parallax of the Moon, right ascension and declination of the Moon, and nutation and aberrational day numbers. Written articles are: "Construction of the Lunar Ephemeris," by W. J. Eckert, R. Jones, and H. K. Clark; "Comparison of the Ephemeris with Brown's Tables," by E. W. Woolard; "Subtabulation of the Moon's Right Ascension and Declination," by A. E. Carter, and "Calculation of the Nutation From the New Series," by G. A. Wilkins.

1,670 RESEARCH IN SPACE SCIENCE
September 16, 1959
Smithsonian Institution, Astrophysical Observatory, Cambridge, Mass.
Special Report 28

This report contains a catalogue of satellite observations for May and June, 1959. Orbital information for the satellites *1958 Alpha, 1958 Beta 1* and *2, 1958 Delta 2, 1958 Epsilon*, and *1959 Alpha 1* and *2* are presented. The data on the observations of *1958 Alpha, 1958 Beta 1* and 2, and *1958 Delta 2* are tabulated.

1,671 **GUIDANCE AND CONTROL OF UNMANNED SOFT LANDINGS ON THE MOON**
Darlington, S.
1959
Bell Telephone Labs., Inc., Murray Hill, N. J.

A guidance and control scheme is described, which may be appropriate for early unmanned soft landings on the Moon. The principal components are: a precision launch phase guidance system; a preset direction and attitude control; main and vernier retrorockets of the solid fuel, fixed impulse type; a range only, pencil-beam radar, nonsteerable relative to the air frame; and means for firing the retrorockets at preset radar range to the Moon's surface. No means are included for measuring the errors in the burning of the main retrorocket, and yet the vernier is so used that the effects of the errors are largely suppressed.

1,672 **ORBITAL TRANSFER FOR SATELLITES**
Altman, S. P.
July 1959
Martin Co., Denver, Colo.
M-M-P-59-50

Orbital transfer between elliptical orbits is formulated by six integral equations with six orbital parameters. The planar orbit is defined by two velocity parameters rather than the conic parameters. Consequently, the orbital and transfer velocities and accelerations are presentable as hodographs of radial and normal components. The set of integral equations may be separated for analysis into two sets of three equations each whenever certain conditions are fulfilled.

Planar orbital transfer by use of two velocity increments is presented in a general formulation, of which the Hohmann transfer ellipse is a special case.

1,673 **IMPULSIVE MIDCOURSE CORRECTION OF A LUNAR SHOT**
Hunter, M. W., Klemperer, W. B., and Gunkel, R. J.
August 1958
Douglas Aircraft Co., Inc., Santa Monica, Calif.
Engineering Paper 674

Recent developments in rocket propulsion have brought space technology to the point where a missile can be dispatched to the Moon. It is obvious that the first lunar expedition should be an unmanned vehicle intended to make either a hard impact on the Moon, or a close passage. Such an experiment could well serve as an exploration for future more sophisticated expeditions.

This paper reviews the results of earlier general investigations of unpowered trajectories in both two-dimensional and three-dimensional Earth–Moon systems, and then indicates the relaxation of accuracy requirements for the launch velocity, both in magnitude and direction, which can be secured by the expedient of an impulsive midcourse correction of a shot to the Moon.

1,674 **SOME INFORMATION-THEORY CONSIDERATIONS IN SPACE COMMUNICATIONS**
Swerling, P.
February 24, 1958
RAND Corp., Santa Monica, Calif.
P-1393

The manner in which the capacity of a communication channel to transmit information is affected by received signal power, system bandwidth, and noise level is discussed in general terms and in the special context of space communication. Examples are given of minimum power requirements for various possible space-communication tasks.

1,675 **LUBRICATION REFERENCE MANUAL FOR MISSILE AND SPACE VEHICLE PROPULSION AT TEMPERATURES ABOVE 700°F**
Macks, F.
January 1959
Tribo-netics Lab., Vermillion, Ohio
WADC TR 58-638, Vol. I, Part I
(ASTIA AD-213,474)

An extensive survey, study and analysis has been made of high temperature (above 700°F) lubrication, friction and wear requirements and problems relating to primary and secondary propulsion systems of missiles, satellites and space vehicles. This reference manual deals with requirements, problems and data associated with relatively moving surfaces for missile, satellite and space propulsion at temperatures above 700°F. The two criteria whereby information has been included in this reference manual are: (a) secondary and primary propulsion requirements, and (b) temperatures above 700°F.

1,676 **COMMUNICATIONS IN SPACE OPERATIONS**
Crain, C. M., and Gabler, R. T.
February 24, 1958
RAND Corp., Santa Monica, Calif.
P-1394

The value of space vehicles operating at great distances from the Earth will be dependent to a high degree on the ability to communicate with these vehicles. Thsi report explores the many practical factors involved in the communication problem, indicates the factors which will influence most strongly the system designs, and points out areas in which research and development appear needed.

1,677 **NUCLEAR EXPLOSIONS IN SPACE (Hearing before the Committee on Science and Astronautics, U. S. House of Representatives)**
U. S. Congress, 86th, First Session
April 10, 1959
U. S. Govt. Printing Office, Washington, D. C.
No. 15

Dr. Herbert F. York and Dr. Frank Shelton describe the Argus Project nuclear weapon tests in space for the committee.

1,678 STATUS OF MISSILE AND SPACE PROGRAMS (Report of the Committee on Science and Astronautics, U. S. House of Representatives)
U. S. Congress, 86th, First Session
1959
U. S. Govt. Printing Office, Washington, D. C.
No. 13

The status of the missile and space programs now in operation in the United States is briefly reviewed by the following agencies: National Aeronautics and Space Administration, Dept. of Defense, Dept. of the Air Force, Dept. of the Army, Dept. of the Navy, and the Central Intelligence Agency. The national tracking program is also mentioned.

1,679 THE ORIGIN OF COSMIC RAYS, USSR (*Priroda*)
Ginsburg, V. L., and Fradkin, M. I.
August, 1958
Translated June 25, 1959
U. S. Joint Publications Research Service, Washington, D. C.
JPRS 775-D, OTS: 59-11667

The objective of this article is to set forth the theory on the origin of cosmic rays. It has been established that in addition to protons, the nuclei of different elements enter into the composition of cosmic rays. On the basis of radio astronomical data, specific conclusions concerning the distribution of cosmic rays in the galaxies and beyond their limits were made. This article considers the experimental data obtained from studies of primary cosmic rays in developing the theory of their origin.

1,680 HEAVY PRIMARY COSMIC RAYS
Young, O. B.
May 1959
Southern Illinois University, Carbondale
Final Technical Report

Techniques for processing 600 micron thick electron sensitive nuclear emulsions are described and suggestions are given for beginners in emulsion plate scanning adapted to heavy nuclear projects. Since the chief way to identify heavy nuclei which produce tracks in emulsions involves delta rays, considerable attention is devoted to a procedure which will give consistent results. The charge identification of heavy nuclei by use of emulsions of different sensitivities is also discussed. Data regarding heavy primary cosmic rays at geomagnetic latitude of 41°N near the geomagnetic equator, and at geomagnetic latitude of 55°N are presented. The relationship between ground level neutrons and high altitude heavy primary cosmic rays is discussed.

1,681 **RESULTS OF SCIENTIFIC INVESTIGATIONS MADE BY SOVIET *SPUTNIKS* AND COSMIC ROCKETS (Presented at the 14th Annual Meeting of the American Rocket Society, Washington, D. C., November 16–20, 1959)**
Krassovsky, V. I.
American Rocket Society, New York
Paper 1050A-59

This paper describes the various experiments which the Russians have performed with their *Sputniks* and cosmic rockets. The results of these experiments are given and interpreted.

1,682 **SOME PROBLEMS OF PROVIDING FOR SCIENTIFIC RESEARCH ON ROCKETS (Presented at the 14th Annual Meeting of the American Rocket Society, Washington, D. C., November 16–20, 1959)**
Blagonravov, A. A.
American Rocket Society, New York
Paper 1052A-59

This paper is designed to show how the Russians solved some of their problems relating to rocket flight. Auxiliary power systems, recovery systems, packaging of instruments, orientation systems, temperature control, and design of ecological systems for rockets are discussed briefly.

1,683 **THE ORBITS OF COSMIC ROCKETS TOWARDS THE MOON (Presented at the 14th Annual Meeting of the American Rocket Society, Washington, D. C., November 16–20, 1959)**
Sedov, L. I.
American Rocket Society, New York
Paper 1051A-59

This paper gives trajectory data on all three cosmic rockets. The experiments contained in each of these probes are explained and some results are included.

1,684 **INVESTIGATION OF THE POLARIZATION OF 10-CM RADIO EMISSION OF THE CRAB NEBULA**
Kuz'min, A. D., and Udal'tsov, V. A.
Pignell, A., Translator
Naval Research Laboratory, Washington, D. C.

The polarization of the radio emission of the Crab nebula at a wavelength of 9.6 cm has been measured. The measurements were made with the 31-m radiotelescope by means of a polarizing radiometer. The sensitivity of the radiometer was equal to 0.6–0.9°K for a bandwidth of 10 mc/s with an image channel) and a time constant of 20 sec. The antenna temperature of one component of nonpolarized emission was equal to $T_a - 100°$.

Several instrumental factors caused by parasitic polarization effects were considered and accounted for.

Linear polarization of radio emission of the Crab nebula has been detected. The degree of polarization is $3 \pm 5\%$. The position angle $\phi - 142° \pm 5°$, and coincides with the direction of the greatest extension of the Crab nebula.

The depolarization effects of the interstellar medium of the Crab nebula have been estimated.

1,685 A COMPUTER PROGRAM FOR OBTAINING REFRACTIVE INDICES AND POLARIZATIONS FROM THE APPLETON-HARTREE EQUATIONS AND MAGNETO-IONIC TABLES FOR CAPE CANAVERAL
Mechtly, E. A.
February 15, 1959
Pennsylvania State University, Ionosphere Research Lab., University Park
Scientific Report 116

Program Cc 126 for the Pennsylvania State University's digital computer PENNSTAC is given. This program has been prepared for the computation from the Appleton-Hartree equations of magneto-ionic refractive indices and polarizations for both modes of propagation. Instructions for using this program are given.

Magneto-ionic tables for Cape Canaveral, Florida, are presented. These tables have been compiled for use in conjunction with the Ionosphere Research Laboratory's project for the determination of electron densities in the ionosphere by means of rockets.

1,686 INTERIM AEROSPACE TERMINOLOGY REFERENCE
October 1959
Air Force Dept., Washington, D. C.
AFP 11-1-4

This pamphlet contains a collection of terms often used in relation to astronautics. The purpose is to provide an adequate terminology guide for people working in this field.

An addendum contains a guide to aerospace systems including aircraft, missiles and spacecraft.

1,687 RECENT STUDIES OF SATELLITE ORBITS (Presented at the 7th Anglo-American Aeronautical Conference, New York, N. Y., October 5–7, 1959)
Cornford, E. C., King-Hele, D. G., and Merson, R. H.
Institute of the Aeronautical Sciences, Inc., New York
IAS Paper 59-141

In order to provide an experimental check on the theoretical work done previously on satellite orbit perturbations a series of photographic observations on all suitable satellites by means of kinetheodolites were compiled in the United Kingdom. These observations have been combined with similar observations from all over the world in order to make a number of deductions about the Earth's gravitational field and the density of the upper atmosphere possible. This paper reviews the results obtained from this effort.

1,688 SOVIET NEWS COVERAGE OF THE FLIGHT OF THE SECOND COSMIC ROCKET TOWARD THE MOON (September 13–20, 1959)
Zygielbaum, J. L., Translator
October 5, 1959
Jet Propulsion Laboratory, California Institute of Technology, Pasadena
AI/Translation No. 10

The following articles appeared in Soviet newspapers after the launching of the second cosmic rocket: "TASS Communique About the Launching of a Cosmic Rocket Toward the Moon by the Soviet Union"; "The Movement of the Second Soviet Cosmic Rocket"; "What Do We Know About the Moon?"; "Photo Recording of the Artificial Comet, New Triumphs"; "TASS Communique, Higher and Higher"; "The Flight of the Second Soviet Cosmic Rocket"; "Astronomers Observed the Artificial Comet"; "Sterility of the Cosmic Rocket"; "From the Earth to the Moon"; "Here She Is, the Artificial Comet"; "Where Did the Rocket Container Land?"; "The Moon: Facts and Presumption"; and, "Next–Mars and Venus"

1,689 *VEGA* SUPPORT-INSTRUMENTATION PLAN
Koukol, J. F., Editor
August 21, 1959
Jet Propulsion Laboratory, California Institute of Technology, Pasadena
Section Report 25-7

The report outlines the *Vega* requirements for launch-to-injection tracking, telemetry, and ground instrumentation, together with implementation plans. The approach to the problem of providing the *Vega* space program with supporting instrumentation has been to balance the need for a good system with the principle of economy. The original development of a large-scale instrumentation program has been avoided and equipment and installations already existing or planned for other programs have been used to the fullest possible extent.

1,690 POSITIONS OF SATELLITE *1958 ALPHA* DURING THE FIRST 1400 REVOLUTIONS
Teske, R. G.
September 5, 1958
Smithsonian Institution, Astrophysical Observatory, Cambridge, Mass.
Special Report No. 17

This report lists positions of satellite *1958 Alpha* at five minute intervals, beginning on February 1.16, 1958, and ending on May 21.50, 1958, covering the period of radio transmission.

1,691 CONTRIBUTIONS OF THE *EXPLORER* TO SPACE TECHNOLOGY
Froehlich, J. E.
July 7, 1958
Jet Propulsion Laboratory, California Institute of Technology, Pasadena
External Publication 526

This report describes the missile design and flight operation of the *Explorer* program and then discusses the scientific measurements made during the program and their significance.

1,692 RESEARCH AND DEVELOPMENT IN CONNECTION WITH HIGH ALTITUDE CLOUD CHAMBER STUDY OF COSMIC RAY NUCLEAR INTERACTIONS
Weaver, A. B.
January 1, 1956–December 31, 1958
University of Colorado, Boulder
Final Report

An apparatus was designed for the purpose of studying high-energy cosmic ray nuclear interactions. It consists of three cloud chambers mounted one above the other, and the associated counters and circuits. This report will state very briefly the program planned but will be concerned chiefly with the apparatus itself since work on the contract has been devoted entirely to building equipment.

1,693 MECHANISM OF EJECTION OF GEOACTIVE CORPUSCLES FROM THE SURFACE OF THE SUN
Mustel, E. P.
CALCIUM EMISSION IN THE SOLAR CORONA
Gnevyshev, M. N., and Gnevysheva, R. S.
Hope, E. R., Translator
June 24, 1954
Canada, Defence Research Board, Directorate of Scientific Information Service
T-134R

In the first paper a preliminary and provisional attack is made on the problem of the mechanism of corpuscular ejection from the faculae. The point of departure for this report is that in the absence of sunspots within the facula-field, the ejection of corpuscles from these fields is in most cases almost radial. There apparently exist only two possible agencies which could bring about such a radial ejection: namely, a radiation pressure and an electric field.

The observation of fine emission lines of ionized calcium have been observed in the centers of the broad H and K lines of the spectrum of the inner parts of the solar corona. The second report described the observation of these lines in the uneclipsed Sun.

1,694 ROCKET MEASUREMENTS OF ELECTRON CONCENTRATION IN THE IONOSPHERE WITH THE AID OF AN ULTRASHORT WAVE DISPERSION INTERFEROMETER, USSR
Gringauz, K. I.
June 11, 1959
U. S. Joint Publications Research Service, Washington, D. C.
JPRS L-1207-D, OTS: 59-11375

The purpose of this paper is to report on certain results of measurements on the distribution by altitude of electron concentration in the atmosphere which were made during the launchings of high-altitude geophysical rockets that reached an altitude of 473 km. The basis of determining the electron concentration was by measurements of the dispersion of radio waves emitted from the rocket which were made by the dispersion-interferometer method.

1,695 STUDY OF STABILITY AND CONTROL CHARACTERISTICS OF ATMOSPHERE-ENTRY TYPE AIRCRAFT THROUGH USE OF PILOTED FLIGHT SIMULATORS (Presented at the 7th Anglo-American Aeronautical Conference, New York, N. Y., October 5–7, 1959)
Creer, B. Y., Heinle, D. R., and Wingrove, R. C. (NASA)
Institute of the Aeronautical Sciences, Inc., New York
IAS Paper No. 59-129

The controllability of certain representative types of aircraft operating in the rapidly changing flight environment of an atmosphere-entry trajectory has been investigated. These studies have emphasized the assessment of the stability and control characteristics when the vehicle is under piloted control. The mechanical setup for these investigations consists of an electronic analog computer for solving the airplane equations of motion, and a fixed or moving cockpit to provide the means for including the pilot in the control loop. The analog computer and cockpit combination is referred to as a flight simulator.

1,696 PASSIVE DAMPING OF WOBBLING SATELLITES, PART 1. GENERAL STABILITY THEORY AND FIRST EXAMPLE
Haseltine, W. R.
July 31, 1959
Naval Ordnance Test Station, China Lake, Calif.
NOTS TP 2306
NAVORD Report 6579, Part 1

The problem of damping the nutational motion of a spinning artificial satellite is considered. It is shown that an internal passive device can damp the nutations of a body when the polar moment of inertia is greater than the transverse, but will lead to instability in the opposite case. One particular form of damper is examined in more detail, and it is found that it will indeed stabilize the axis if its parameters obey a certain condition. If they do not, a stable motion will result, but the axis of rotation will not be the axis of symmetry of the satellite.

1,697 **FOUR RUSSIAN SCIENTISTS DISCUSS THEIR DISCOVERIES IN COSMOS** (*Tempo*)
Capone, C.
April 28, 1959
Viterbi, A. J., and Zygielbaum, J. L., Translators
September 15, 1959
Jet Propulsion Laboratory, California Institute of Technology, Pasadena
AI/Translation No. 1

This discussion includes material on the Van Allen Radiation Belt and on general space radioactivity.

1,698 **INSTRUMENTATION FOR SPACE SCIENCE RESEARCH (Presented at the 7th Anglo-American Aeronautical Conference, New York, N. Y., October 5–7, 1959)**
Townsend, J. W., Jr. (NASA)
Institute of the Aeronautical Sciences, Inc., New York
IAS Paper No. 59-127

This report discusses the national effort in the development of payload systems for rockets, Earth satellites, and space probes. These systems include the specialized instrumentation and structures necessary to conduct scientific experiments. The development of such devices is a highly specialized systems problem, the elements of which are the sensing devices, the special electronic devices such as command receivers and control circuits, telemetry transmitters, power supplies, mechanical structures, testing procedures, vehicle characteristics, tracking systems, data handling methods, and analysis of the scientific data. Instrumentation must have certain essential characteristics such as reliability, ruggedness, low weight, small size, extreme sensitivity, excellent repeatability, and reasonable cost. Successful space devices can be created only after consideration of all of the system elements, careful selection of the many components, and thorough testing.

1,699 **THEORETICAL INVESTIGATION OF THE ABLATION OF A GLASS TYPE HEAT PROTECTION SHIELD AT THE STAGNATION POINT OF A RE-ENTERING SATELLITE**
Adams, E.
August 28, 1959
Army Ballistic Missile Agency, Redstone Arsenal, Ala.
R-DA-TR-62-59

The transient liquid film at the stagnation point of a ballistic satellite descending through the atmosphere is computed by evaluating a previously developed calculation method.

The assumed satellite has a nose diameter of 0.635 m, a ballistic factor of 30×10^{-3} $m^3/kg\ sec^2$, a re-entry angle of 92.35° (from the vertical) at an altitude of 150 km and a re-entry velocity of 7900 m/sec. A homogeneous heat-protection shield consisting of glass of low-thermal conductivity is assumed. Any mass transfer from the liquid film into the air boundary layer is neglected.

Melting was found to begin at an altitude of about 78 km and to end at an altitude of about 35 km. Despite the low level of the interface (= surface) heat flux, which is smaller than 70 kcal/m² sec, the interface temperature reaches almost 2700°K at an altitude of 57 km and the effective heat of ablation a maximum of 613 kcal/kg at the same altitude. Appreciable melting occurs only between the interface temperatures of 2000 and 2700°K, i.e., at fairly high values of the effective heat of ablation. The ablation velocity reaches a maximum of 0.062 mm/sec at an altitude of 57 km, and the total ablation of the homogeneous glassy heat protection shield is 5.2 mm. Melting ends at an interface temperature of about 1600°K.

Due to the high interface temperature, radiation turns out to be the predominant cooling effect. About 87% of the total aerodynamic heat convected to the interface is radiated into the air, and at the altitude of 38 km, a few seconds before melting ends, radiation cooling becomes larger than the aerodynamic heat convected to the interface, and the heat flux is reversed from there on. At this altitude, about 74% of the total previous time integrated-net heat input into the interface has been shed with the molten film.

The interface temperature is smaller by less than 50°K than its value without melting, i.e., for a hypothetical glass with infinite viscosity. It is therefore obvious that for the satellite case under discussion, the thermal diffusivity (as governing parameter of the nonmelting case) is an important performance parameter of the melting glassy heat-protection shield.

1,700 A STUDY OF HYPERSONIC ABLATION (Presented at the Tenth Annual Congress of the International Astronautical Federation, London, Aug. 30–September 5, 1959)
Scala, S. M.
September 30, 1959
General Electric Co., Philadelphia, Pa., Aerosciences Lab.
R59 SD 438

The aerothermochemical response of four broad classes of materials to the severe heating encountered during the hypersonic re-entry of space vehicles is determined theoretically. These materials include quartz-like refractories, graphite, thermosetting plastics and thermoplastics.

The conclusions reached in this report are: (1) a unified treatment of the ablation of different classes of materials has been developed, (2) the effective heat of ablation of each material depends critically on the enthalpy level of the flight environment, and increases with increasing flight speed, (3) the effect of an increase in stagnation pressure is to promote a decrease in the effective heat of ablation, and (4) the specific area of greatest uncertainty is in the kinetics of condensed phase heterogenous reactions.

1,701 REMARKS ON THE DECAY OF *1958 ZETA*
Delaney, W. A.
May 1959

Air Force Cambridge Research Center, Bedford, Mass., Space Flight Physics Lab.
AFCRC-TN-59-454, GRDST-5

Part 1 of this report discusses the decay of *1958 Zeta* briefly. Its last observed revolution and the decrease in its period are presented graphically. In Part 2 the last three sighting reports are given.

1,702 **A HIGH PRECISION STELLAR NAVIGATOR FOR INTERPLANETARY GUIDANCE**
Bock, C. D.
1959
American Bosch Arma Corp., Arma Division, Garden City, N. Y.

This report describes the design of a mid-course navigation system which is simple and still offers high precision. The design is based on the astronomical principle of using the relative shift of the stars with respect to the positions of distant stars nearby on the celestial sphere to measure the distance to nearer stars. The proposed navigation system uses a photographic technique with the already calibrated celestial sphere.

If a manned vehicle is considered, the navigation system consists only of taking a photograph and supplying the grade of stabilization needed to keep the star images adequately sharp for measurement on the comparator microscope. If the navigation instrument is made automatic, additional problems would be encountered.

1,703 **SPACE INVESTIGATIONS—SELECTED TRANSLATIONS (*Izvestia*, July 7–8 and September 2, 1959)**
Zygielbaum, J. L., Translator
September 10, 1959
Jet Propulsion Laboratory, California Institute of Technology, Pasadena
AI/Translation No. 9

This report is divided into two sections. The first section deals with high-altitude flight of experimental animals and includes the following articles: "TASS Communique"; "The Assault on the Upper Atmosphere Continues"; "Nearing the Great Goal"; "A Tremendous Scientific Achievement"; "Scientists Peek into Cosmos"; "The Third Flight of 'Courageous'"; "This is Very Interesting"; and "Where is 'Snowflake'?" Part II contains the article, "Where is the Soviet Solar Satellite Now?"

1,704 **HIGHER ATMOSPHERIC DENSITIES AND TEMPERATURES DEMANDED BY SATELLITE AND RECENT ROCKET MEASUREMENTS (Presented at the ARS Controllable Satellite Conference, M.I.T., April 30–May 1, 1959)**
Minzner, R. A.

Geophysics Corp. of America, Boston, Mass.
American Rocket Society, New York
781-59

This report is divided into two sections, the first of which deals with the density data published prior to and since the development of the 1956 ARDC Model Atmosphere and the second dealing with the development of the 1959 ARDC Model Atmosphere.

1,705 **FUNDAMENTAL FLIGHT DYNAMICS AND STAGING**
(Summary of Lecture IV(a) for UCLA Course X431DEF—
Ballistic and Space Vehicles Systems)
October 6, 1959
Hibbs, A. R.
Jet Propulsion Laboratory, California Institute of Technology,
Pasadena
External Publication 705

The Vacuum-Velocity Law is developed and is then applied to the case of vertical flight near the Earth's surface. The motion over a spherical non-rotating Earth and motion in an inverse square field are considered. Finally, the problems of interplanetary flight are discussed.

1,706 **INTERPLANETARY TRAJECTORY SIMULATION**
Walker, J. C.
September 10, 1958
Douglas Aircraft Co., Inc., Santa Monica, Calif.
SM-27742

A three-dimensional simulation of missile flight through a solar system which may include the Sun, Moon, and nine planets has been programmed on the IBM 704. The program considers only gravitational forces and, hence, is presently restricted to use outside the atmospheres of various bodies. The approach was used to obtain positions and velocities of all bodies by integration of Newton's law of gravitation. Initial conditions are taken from the "American Ephemeris and Nautical Almanac." This report details the assumptions, explains how this approach leads to a simple, small, expandable program, and derives the equations.

1,707 **OPTIMUM FREQUENCIES FOR OUTER SPACE COMMUNICATION**
July 1958
U. S. Dept. of Commerce, Washington, D. C.
Office of Technical Services
P B 151 629

This report has been written for the purpose of providing Army frequency officers, engineers, and project officers with a general appreciation of the propagation and frequency aspects of space communications as known to date and giving a point of departure for further study and discussion of this subject.

1,708 **PELTIER COOLING OF ELECTRICAL COMPONENTS IN TELEMETERING PACKAGES (Presented at the ARS Semi-Annual Meeting, June 8–11, 1959, San Diego, Calif.)**
Marlow, R.
Texas Instruments, Inc., Dallas, Central Research Labs.
American Rocket Society, New York
Paper 841-59

Telemetry systems are required in missiles and satellites to process electrical impulses and transmit information to a ground receiving station. Inside the telemetry package there are various electrical components that would have increased life expectancy if an adequate thermal environment could be provided. Peltier cooling, a direct method of converting electrical energy into usable thermal energy, is a method of obtaining this environment. Current passing across a junction of two semiconductor materials causes one junction to absorb heat and the other to liberate heat. The limiting factor to this method of cooling is the semiconductor material that is used to make the thermoelectric thermoelement. An example of how Peltier cooling may be applied to telemetry packages is illustrated in this paper.

1,709 **UPPER ATMOSPHERE RESEARCH REPORT NO. XXXV GROUND STATIONS FOR NRL ROCKET STUDIES OF THE IONOSPHERE**
Jackson, J. E., and Spaid, G. H.
August 31, 1959
Naval Research Laboratory, Washington, D. C.
NRL Report 5342

Between 1946 and 1958, a total of 23 rocket flights have been instrumented by NRL to measure electron densities in the ionosphere and to investigate various related phenomena. The measurements were based upon the transmission of cw signals from a rocket to receiving and recording stations on the ground. The nature of the experiments required phase comparisons between two harmonically-related frequencies. Since commercial receivers are unsuitable for this purpose, special receiving equipment was designed by NRL scientists to meet the experimental requirements. Particular considerations were given to bandwidth noise, dynamic range, phase stability, signal-strength metering, and input circuitry. The extremely narrow-bandwidth operation which is possible with the cw method led to the design and use of a new type of crystal filter in the receiving system. The need for separate reception of the ordinary and extraordinary modes of propagation led to a novel adaptation of the magic T at 7.75 mc. A two-station system, first used at White Sands, New Mexico, was later, during IGY, transferred to Ft. Churchill, Canada. A number of unusually stable, narrow-band rf sweep generators were developed to test, adjust, and calibrate the ground-station equipment.

1,710 **RESEARCH IN SPACE SCIENCE**
Jacchia, L. G.
September 21, 1959
Smithsonian Institution, Astrophysical Observatory,
Cambridge, Mass.
Special Report No. 29

This report contains the paper, "Solar Effects on the Acceleration of Artificial Satellites." Four distinct types of fluctuations in the acceleration of satellites are discussed. These are:

(a) Fluctuations that follow the rhythm of the solar flux at 2800 mc (10.7 cm wavelength). These fluctuations increase in amplitude with height and become smaller or disappear when the perigee is in darkness. It appears very probable that these fluctuations reflect variations in atmospheric density caused by variable short-wave solar radiation (extreme UV).

(b) A slow fluctuation connected with the position of the perigee with respect to the sub-solar point ("diurnal effect"). This effect is small at the 200-km level, but becomes very large at heights larger than 350 km. This effect is intimately connected with (a) and should have the same primary agent (UV absorption) as its origin. It reflects a difference in the density profiles of the bright and the dark hemispheres of the earth.

(c) Transient fluctuations accompanying magnetic storms. These perturbations are seemingly of corpuscular origin and should reflect a heating of the atmosphere through some interaction with corpuscular radiation.

(d) Erratic fluctuations of unexplained origin, such as the perturbation of August and September 1958. It is felt that a comparison with conditions in the radiation belts may provide a clue to this effect.

1,711 **TRACKING *PIONEER IV* BEYOND THE MOON**
Anderson, R. E.
July 1959
General Electric Co., Schenectady, N.Y.
Report No. 59GL171

This report describes General Electric's efforts in tracking the *Pioneer IV* from a temporary station installed at the research laboratory at Schenectady.

The 18 foot parabolic antenna was used in connection with a low noise parametric amplifier designed by General Electric. This amplifier enabled reception superior to that available from the system when the amplifier was removed.

1,712 **ARTIFICIAL EARTH SATELLITES**
Zygielbaum, J. L., Translator
September 4, 1959
Jet Propulsion Laboratory, California Institute of Technology,
Pasadena
AI/Translation No. 2

The following articles dealing with results of scientific investigations obtained with the help of *Sputnik III* have been translated and are presented in this report: "The Dynamic Effects on the Motion of Earth Satellites"; "Certain Results of Measurements of Thermodynamic Parameters of the Stratosphere Using Help of Meteorological Rockets"; "Perturbations of the Gas Environment Caused by a Flight of a Satellite"; "Preliminary Results in Determining the Atmospheric Density Above 100 km"; "Investigation of the Ion Composition of the Earth's Atmosphere with Rockets and Satellites"; "Soviet Investigations of the Ionosphere with the Help of Rockets and Satellites"; "Preliminary Report on Geomagnetic Measurements by the Third Soviet Earth Satellite"; "Investigation of Micrometeorites with Rockets and Satellites"; "Discovery of Corpuscles with the Help of *Sputnik III*"; "The Study of Soft Components of Cosmic Rays Beyond the Limits of Atmosphere"; "Heavy Nuclei in Primary Cosmic Radiation"; "Solar Batteries"; and "Acoustical Method for the Measurement of Mechanical Parameters of Meteorites."

1,713 PHOTOGRAMMETRIC DETERMINATION OF A PORTION OF THE ROCKET TRAJECTORY OF THE INFLATED BALLOON SATELLITE (AM-19B)
Schmid, H. H.
September 1959
Ballistic Research Laboratories, Aberdeen Proving Ground, Md.
Technical Note No. 1277

A time-coded trail of a portion of the trajectory of the rocket associated with the "Inflated Balloon Satellite Experiment," launched on August 14, 1959, was recorded on a photograph taken by the Grumman Astronomical Society, Bethpage, New York, together with time-coded star trails. At the request of NASA (in behalf of ABMA, Redstone), spatial directions, as a function of time, have been determined for a number of points on the trajectory of the rocket.

1,714 MICROMETEORITES, HIGH VELOCITY IMPACT STUDIES, AND PROBLEMS OF SPACE TRAVEL RELATING TO PARTICLE IMPACT
Barber, E., and Sweitzer, D. I.
October 15, 1959
Jet Propulsion Laboratory, California Institute of Technology, Pasadena
AI/Literature Search No. 143

The purpose of this report is to contribute information concerning the existence of micrometeorites, interplanetary dust and other small particles in space and their possible influence on interplanetary flight. Available material was covered through July 31, 1959.

1,715 *LUNIK III*—SOVIET NEWS COVERAGE OF THE THIRD SOVIET COSMIC ROCKET
October 4–30, 1959
Zygielbaum, J. L., Translator
November 16, 1959
Jet Propulsion Laboratory, California Institute of Technology, Pasadena
AI/Translation No. 14

The articles in this report cover the Soviet reports on the flight of *Lunik III* and discuss the scientific information, specifically the photographs of the invisible side of the Moon, obtained from the flight.

1,716 PERFORMANCE ANALYSIS OF BIOLOGICAL GAS EXCHANGES FOR CLOSED ECOLOGICAL SYSTEMS
Hobby, G. L.
November 17, 1959
Jet Propulsion Laboratory, California Institute of Technology, Pasadena
External Publication 804

The feasibility of constructing small, compact biological gas-exchanger units for application in space vehicles is evaluated.

The essential function of photosynthetic gas exchangers in a sealed space cabin is the generation of oxygen and the absorption of carbon dioxide at a rate which will be in equilibrium with the carbon dioxide production and oxygen consumption of a human crew.

1,717 COSMIC RAYS AS SOURCE OF THE GALACTIC RADIO EMISSION
Ginzburg, V. L.
Doklady Akademii Nauk, v. 76, no. 3, pp. 377–380, 1951
Hope, E. R., Translator
June 18, 1954
Canada, Defence Research Board, Directorate of Scientific Information Service
T132

The idea considered is that the galactic radio emission is a Bremsstrahlung of relativistic electrons in interstellar and circumstellar magnetic fields.

1,718 COMMENTS ON THE QUESTION OF THE EXISTENCE OF A LUNAR MAGNETIC FIELD
Neugebauer, M.
November 4, 1959
Jet Propulsion Laboratory, California Institute of Technology, Pasadena
External Publication 800

The possible existence of a lunar magnetic field of less than 6×10^{-4} gauss on the surface is discussed. It is suggested that if a general lunar magnetic field existed, it would be confined by the solar corpuscular radiation, or solar wind, to a thin layer above the sunlit surface, but it could extend a considerable distance beyond the surface on the side away from the Sun.

1,719 BIBLIOGRAPHY OF EXTRATERRESTRIAL RADIO NOISE—FIFTH QUARTERLY LIST OF RECENT PUBLICATIONS
Carpenter, M. S.
September 15, 1958
Cornell University, Ithaca, New York
Research Report EE 414

1,720 OBSERVATIONS OF MARS IN 1958
de Vaucouleurs, G.
Harvard College Observatory, Cambridge, Mass.
September 15, 1959
Air Force Cambridge Research Center, Bedford, Mass.
AFCRC-TN-59-476
U. S. Dept. of Commerce, Washington, D. C.
Office of Technical Services

This paper contains a report on visual and photoelectric observations of Mars in October and November, 1958 which were made at the Lowell Observatory, Flagstaff, Arizona.

Monochromatic magnitudes and albedos are given of λ 3300, 3600, 4550, 5550, 6900 Å.

Thirty-two drawings illustrate the main visual surface features and cloud phenomena. Several surface changes and an outstanding moving cloud system are discussed.

1,721 METHODS AND VELOCITY REQUIREMENTS FOR THE RENDEZVOUS OF SATELLITES IN CIRCUMPLANETARY ORBITS
Brunk, W. E., and Flaherty, R. J.
October 1959
National Aeronautics and Space Administration,
Lewis Research Center, Cleveland, Ohio
Technical Note D-81

In the future of space flight there will be occasions when it is necessary to perform a rendezvous between two satellites in orbit around a planet. For a spherical planet methods of rendezvous are considered in which the total velocity required is close to a minimum. Since some of the planets are not spherical, the assumption of a spherical planet does not always apply. For the case of the Earth, the effects of oblateness on rendezvous are considered.

1,722 DEPARTURE TRAJECTORIES FOR INTERPLANETARY VEHICLES
Moeckel, W. E.
November 1959
National Aeronautics and Space Administration,
Lewis Research Center, Cleveland, Ohio
Technical Note D-80

General expressions are derived for the magnitude and direction of the launching velocity needed to reach another planet from any point on the Earth's surface. The effect of the inclination of the orbital plane of the destination planet is considered, as well as the effect of departure date and selected trajectory. A procedure is given for determining optimum time of day for launching from any latitude to obtain maximum benefit of the Earth's rotation. Results of the analysis are illustrated for typical Earth-Venus trajectories.

1,723 SOME THRUST AND TRAJECTORY CONSIDERATIONS FOR LUNAR LANDINGS
Weber, R. J., and Pauson, W. M.
November 1959
National Aeronautics and Space Administration,
Lewis Research Center, Cleveland, Ohio
Technical Note D-134

A proposed method for accomplishing soft landings on the Moon is first to establish a circumlunar orbit and then to transfer to the lowest acceptable altitude by a minimum-energy elliptical path. After braking to a halt, a vertical descent is made consisting of free fall and a final upward thrust application to decelerate the vehicle. The characteristic-velocity increment for a typical landing (starting from orbit) is 6880 ft/sec. The effects of trajectory errors and thrust level are discussed.

1,724 LIMITED INVESTIGATION OF CRUSHABLE STRUCTURES FOR ACCELERATION PROTECTION OF OCCUPANTS OF VEHICLES A LOW IMPACT SPEEDS
O'Bryan, T. C., and Hatch, H. G.
National Aeronautics and Space Administration,
Langley Research Center, Langley Field, Va.
Technical Note D-158

A limited investigation has been made to determine the characteristics of three materials to see how they can be applied for human protection against accelerations encountered at low impact speeds.

1,725 PREDICTED CHARACTERISTICS OF AN INFLATABLE ALUMINIZED-PLASTIC SPHERICAL EARTH SATELLITE WITH REGARD TO TEMPERATURE, VISIBILITY, REFLECTION OF RADAR WAVES, AND PROTECTION FROM ULTRAVIOLET RADIATION
Wood, G. P., and Carter, A. F.
October 1959
National Aeronautics and Space Administration,
Langley Research Center, Langley Field, Va.
Technical Note D-115

An investigation was made to predict whether or not a hollow aluminized-plastic sphere in a terrestrial orbit at an altitude of about 1000 miles would have the following characteristics: (1) easily visible to the naked eye, (2) a good reflector of radar waves, (3) protected from deterioration of the plastic by ultraviolet radiation, and (4) assume acceptable extremes of temperature. It was found that a 2200-Å-thick coating of vapor-deposited aluminum on ¼-mil-thick Mylar forming a 100-foot-diameter sphere would probably meet all requirements regarding radiation.

1,726 IMPORTANCE OF THE VARIATION OF DRAG WITH LIFT IN MINIMIZATION OF SATELLITE ENTRY ACCELERATION
Grant, F. C.
October 1959
National Aeronautics and Space Administration,
Langley Research Center, Langley Field, Va.
Technical Note D-120

The present investigation shows that the use of realistic-drag polars leads to lower peak accelerations than those obtained on the assumption of constant drag coefficients, which, in effect, limits the aerodynamic coefficients to the low-drag side of maximum lift-drag ratio. An acceleration parameter is derived which defines the minimum peak acceleration in terms of a simple integral of the aerodynamic coefficients of the vehicle. Numerical calculations are presented for an entry vehicle with a simplified but realistic complete drag polar. These calculations are in good agreement with the results obtained by use of the acceleration parameter.

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